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ABSTRACT

This curriculum guide is designed to provide students with an overview of the duties, procedures, concepts, tools, and equipment used in the auto body industry. This introductory course will prepare students to undertake training in one or more specialty areas of the auto-body trade. Suitable for secondary, postsecondary, or adult education programs, this curriculum guide contains 13 instructional units. The units cover the following topics: orientation, safety and basic first aid, paint and body shop safety, mathematics and measuring, interior detailing, body and frame construction nomenclature, general hand tools, body and refinishing equipment, fasteners, circuits and wires, battery service, engine cooling system, and air conditioning system. The guide follows a standard format that includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. Depending on the specific objectives, there may or may not be transparency masters, supplements, assignment sheets, or job sheets included in the unit of instruction. (KC)

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Introduction to Auto Body

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Developed by
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INTRODUCTION TO AUTO BODY

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FOREWORD

In Oklahoma, vocational educators have a basic belief that quality vocational programs require the use of sound instructional materials. A comprehensive approach with a quality treatment served as the primary approach when the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center began revisions of its instructional guide for the auto-body trade. This volume, *Introduction to Auto Body*, provides students in this area with an overview of the duties, procedures, concepts, tools, and equipment used in the industry. Every effort has been made to address the latest in technology with a special concern for the safety and health aspects associated with auto-body occupations.

Industry representatives, educators, and technical specialists collaborated closely to produce these materials in the hope that students will gain the knowledge and skills required in the auto-body trade through practical learning experiences. Coupled with the instructor's own methods and expertise, the materials should prove to be a valuable asset for a progressive auto-body training program.

It is our sincere wish that the manuals in this series will contribute to the development of a competent, safety-conscious work force in the auto-body trade.

Dr. Francis Tuttle, Director
Oklahoma State Department of
Vocational and Technical Education

Ivan Armstrong, State Supervisor
Trade and Industrial Education
Oklahoma State Department of
Vocational and Technical Education

PREFACE

The purpose of *Introduction to Auto Body* is to prepare the student to undertake training in one or more specialty areas of the auto-body trade. Instructional materials are also being developed for body repair, frame repair, refinishing, and shop management. Each volume has been carefully reviewed and validated by a committee of industry and education representatives concerned with presenting the latest advances of the trade.

These curriculum materials have been designed for use in full-time secondary and post-secondary classes, as well as part-time adult classes. The material is easily adaptable to open-entry, open-exit programs to allow students to progress at their individual paces.

A skilled instructor will be able to supplement, personalize, and localize this material to meet specific training needs. The design of the material allows the different topics to be presented in a variety of sequences, and even permits the use of part of a unit of instruction at a given time. The "Use of this Publication" section will greatly aid the instructor and student in getting the most from these materials. Additionally, the CIMC staff will be glad to assist you in tailoring these materials to your needs.

Bob Patton, Coordinator
Curriculum and Instructional
Materials Center
Oklahoma State Department of
Vocational and Technical Education

ACKNOWLEDGEMENTS

Any project as comprehensive and involved as this guide for teaching auto-body repair requires the contributions of a great number of people. We are thankful for the tremendous support we have received in the development of this book. We are especially grateful to Ed Manuel, Business Manager of O.T. Autry Area Vo-Tech School, Enid, Oklahoma, who wrote the original CIMC auto-body publication and who served as a special consultant on this work. His years of experience as an instructor and work in his family-owned shop were a valuable contribution to this project.

Throughout the development of this book, we were guided by an able panel of experts from both the industry and education. This committee designed the scope and sequence of all the materials contained in this series and reviewed the completed materials for technical accuracy, teachability, currency, and industry relevance. We are especially grateful for the assistance given by representatives of the Independent Automotive Service Association and the Inter-Industry Conference on Automotive Collision Repair (ICAR). The review committee included

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Owner and President
R and M Body Shop
Chickasha, Oklahoma

We owe a great deal of gratitude to members of the Oklahoma State Department of Vocational and Technical Education staff who made the project possible, especially to Dr. Francis Tuttle, State Director; Ivan Armstrong, Trade and Industrial State Supervisor; and Bob Patton, CIMC Coordinator. These men recognized the need for these materials and dedicated the resources to see that the project was completed. We gratefully recognize the contributions of Dean Myers, who represented the Trade and Industrial Division, and Robert Hilley, who served as project coordinator for the CIMC.

We are also thankful to the many people involved in the production process. Writing assistance and editorial guidance were provided by Susan Walker, CIMC Technical Writer. Susan received assistance from the editing staff, supervised by Terri Barnes; we offer thanks to Sue Buck, Jerry Weir, and Marsha Sneed. We are also thankful to those in the Communications Center, under Debbie Hixson, who prepared the many drafts of this manual, with special thanks to Rose Primeaux, Stephanie Shipley, and Lisa Tomlinson.

The illustrations for this publication came from a number of sources. We are thankful to the many companies and publishers who contributed artwork, identified by the permission lines accompanying many of the illustrations. We are also grateful for the splendid work done by the Art Department, under Bob Davis, and especially to Gary Bradley, Kim Hale, Kathryn Hansen, Robert Randall, and Scott Stone, who served as illustrators on this project. Recognition also is due to Tom Fields of the CIMC Media Unit who did the photographic work for this volume.

The quality of the published product is the result of the care and talents of the Print Shop personnel under the supervision of Noel Wilcoxson. None of this would have been possible without the dedication and skills of the CIMC secretarial staff under Judy DeVaughan, and especially the assistance of Janette Nicholson, secretary to the Development Unit. To these and many others, we are extremely grateful to have shared in this team effort.

It is our sincere hope that these materials will be of value to auto-body instructors and that they benefit those students who pursue careers in this vital and rewarding field.

James Sharpton

Bill Litton

USE OF THIS PUBLICATION

Instructional Units

Introduction to Auto Body contains thirteen instructional units. A standard format was established in 1970 for development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. Depending on the specific objectives, there may or may not be transparency masters, supplements, assignment sheets, or job sheets included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

- Amount of material that can be covered in each class period
- Skills that must be demonstrated
 - Supplies and equipment needed
 - Amount of practice needed
 - Amount of class time needed for demonstrations
- Supplementary materials, such as pamphlets and filmstrips, that must be ordered
- Resource people to contact

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the performance necessary to reach the unit objective. Since the objectives of the unit provide direction for the teaching/learning process, it is important that teachers and students have a common understanding of the intent of the objectives.

The objective sheet should be given to students and referred to throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may also be used as a quick pretest to determine students' prior knowledge and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested Activities (pink pages)

Suggested activities are included only in teacher materials. The suggested activities pages include an outline of the unit contents and an instructor's guide designed to assist teachers in planning their presentation of the unit. The instructor's guide provides suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed in the suggested activities are ones used in the development of each unit. They may be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

The suggested activities section of the unit also includes supplements and transparency masters. Each of these components provides information in a special way. Supplements may consist of motivational materials, review or practice materials such as crossword puzzles and self-tests, or charts and reference materials. Supplements are designed to be copied and distributed to individual class members or to the class as a whole. Suggestions for their use are included in the instructor's guide. Transparencies direct the class' attention to the topic of discussion. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification or analysis is necessary. Order transparencies from the Curriculum and Instructional Materials Center, or make transparencies and place them in the notebook where they will be immediately available for use.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical-outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience. They assist students in the application of knowledges that are necessary prerequisites to skill development. Assignment sheets may be given to the student for completion in class or may be used for homework assignments. Answer sheets are provided when appropriate and can be used by the student and/or teacher for checking student progress. The scores of those assignment sheets listed in the specific objectives should be averaged with the unit test score, as the skills addressed in these assignment sheets are considered necessary in meeting the unit objective.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

The teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Job sheet performance should be evaluated by the instructor and averaged with the unit test score, as the skills addressed in the job sheets are considered necessary in meeting the unit objective.

Tests (yellow pages)

The test provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test, 85 percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score and evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

Answers to test and assignment sheets are components designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center (CIMC) is assigned a specific abbreviation. For example, *Introduction to Auto Body* has been abbreviated IAB. The units are then numbered consecutively within each section. An example of a page number is IAB-1. Since CIMC publications are loose leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder for the units. This is convenient for taking the materials home to study. Upon completion, each unit is then placed in a larger binder. The large binders may be purchased at cost from the CIMC. Some teachers store the materials by units in filing cabinets or boxes until needed. All the units may be given out at once if desired.

For best results, provide student materials for each student. Student materials contain everything but the test answers, answers to assignment sheets, and suggested activities. All tests are collated at the back of student material and should be removed and stored until needed.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

Competency Profiles

Competency profiles are folders used to document student performance. The profile contains a list of the specific job competencies that a student should achieve prior to leaving the training program. Competency profiles may be ordered from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. You can mail the information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, it is important that you notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Manager of Development
Curriculum and Instructional Materials Center
Oklahoma State Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074

ORIENTATION TO AUTO BODY
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to discuss Trade and Industrial Education and auto-body occupational employment opportunities. The student will show this knowledge by completing the assignment sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Define *Trade and Industrial Education*.
2. List guidelines for becoming a responsible auto-body technician.
3. List facts concerning the occupational outlook for auto-body technicians.
4. Name employment opportunities for auto-body technicians.
5. Complete an auto-body industry survey.

ORIENTATION TO AUTO BODY
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Supplement #1 — Personal Information Sheet
- D. Information sheet
- E. Assignment Sheet #1 — Complete an Auto-Body Industry Survey
- F. Answers to assignment sheet
- G. Test
- H. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Order materials to supplement the unit.

1. *VICA: Learn, Grow, Become*

(NOTE: This manual and the competency profiles listed below are available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

2. Competency profiles

- C. Before beginning instruction, read Unit I, "VICA Club Orientation," of *VICA: Learn, Grow, Become*.
- D. Using the suggested activities portion of "VICA Club Orientation" as a guide, discuss the advantages of participation in VICA (Vocational Industrial Clubs of America).

SUGGESTIONS:

- Invite officers from VICA to explain briefly to the class their club's organization and purposes.
- Stress the four reasons for having 100 percent membership in VICA:
 - 1. Club involvement gives students a feeling of unity, identity, and pride.

SUGGESTED ACTIVITIES

2. All students have the same opportunity to develop communication, organization, teamwork, and leadership skills. These leadership skills are also job skills.
3. VICA programs offer students challenges that encourage them to develop their trade skills, and students can work at their own pace.
4. Active VICA programs give every student an opportunity to make employer and community contact through club activities.

E. Introduce unit to students.

SUGGESTIONS:

- Ask whether any of the students have recently had an automobile in a body shop for repairs. Discuss the background and knowledge that was required for the repairs to be completed.
- Explain that there are two types of auto-body technicians: repairers (body technicians) and automotive refinishers (painters).

The repairer is an individual trained in the skills and technology of repairing minor (cosmetic) sheet-metal damage as well as the welding and repairing of major collision damage. Major collision repair involves the alignment and the replacement of sheet-metal components, frame sections, electrical systems, mechanical parts, automotive glass, and interiors.

Automotive refinishers are individuals trained in the artistic skills of automobile painting. They are responsible for the preparation and application of various topcoats (finishes); therefore, they must be skilled in the color matching of all automotive refinishes. Their responsibilities include sanding, masking, and applying undercoats, sealers, and topcoats.

The auto-body technician works in conditions that are sometimes difficult for people with respiratory problems. Those persons considering the trade as a vocation should be aware of this fact.

F. Provide students with unit.

G. Discuss unit and specific objectives.

H. Discuss information and assignment sheets.

1. Use Information Sheet, Section I to explain Trade and Industrial Education.

SUGGESTIONS:

- Explain how the auto-body trade is part of the Trade and Industrial Education program.

SUGGESTED ACTIVITIES

- Ask students to name Trade and Industrial Education trade areas. List on chalkboard or make a transparency of various trade areas.

EXAMPLES:

Aircraft mechanics	Floriculture
Appliance repair	Horticulture
Auto-body repair	Industrial maintenance
Auto mechanics	Machine shop
Brick masonry	Photography
Building trades	Plumbing
Cabinetmaking	Printing
Commercial art	Refrigeration and air conditioning
Cosmetology	Radio and television
Diesel mechanics	Sheet metal
Drafting	Small engine repair
Electrical trades	Upholstery
Electronics	Welding
Farm equipment repair	

2. Use Information Sheet, Section II to discuss guidelines a student should follow to become a responsible auto-body technician.

SUGGESTION:

- Explain to students your expectations (rules) for the class. Items of discussion may include such things as time schedule and operating rules, breaks, smoking rules, absences, illness, accident procedure, punctuality, and clean-up procedures.
3. Discuss the occupational outlook for auto-body technicians. Use Information Sheet, Section III.

SUGGESTIONS:

- Explain to students that more than 185,000 people are employed nationally as auto-body technicians.
- Explain that auto-body work (repair and painting) of automobiles and trucks has become one of the fastest growing and most important industries in the modern world.
- State that because of the increased number of automobiles driven, accident rates continue to increase; therefore, the number of auto-body technicians needed also increases.
- Discuss the variety of jobs available in the auto-body field, emphasizing those that require skills taught in this course.

SUGGESTED ACTIVITIES

EXAMPLES: Body technician's helper, painter's helper, body shop manager, commissioned body technician, commissioned painter, body shop owner, auto-glass specialist, fiberglass repair specialist, parts counter attendant, industrial automobile assembler, automotive-supply salesperson, fleet repair specialist, custom repairer, and painter

4. Use Information Sheet, Section IV to discuss employment opportunities for auto-body technicians.

SUGGESTIONS:

- Discuss working in a large shop as compared to working in a small shop, specialization as compared to doing it all.
 - Talk about benefits or compensations other than take-home pay. Compare such compensations from a large shop with those from a small shop.
5. Have students complete Assignment Sheet #1 and Supplement #1.

SUGGESTIONS:

- Explain to students that the information in Supplement #1 is needed for your files. This information will be used to contact someone in case of an accident requiring more than first aid. This information is also needed for the student environment and follow-up forms required by the State Department of Vocational and Technical Education.
- Critique Assignment Sheet #1 and discuss in class.

- I. Give test.

- J. Critique test and discuss in class.

- K. Reteach and retest if necessary.

- L. Complete appropriate section of competency profiles.

III. Unit references

- A. *Occupational Outlook Handbook 1980-81*, Bulletin No. 2075. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, March 1980.
- B. Patton, Bob, et al. *VICA: Learn, Grow, Become*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1984.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — PERSONAL INFORMATION SHEET

NAME _____ SOCIAL SECURITY NO. _____

HOME ADDRESS _____

HOME PHONE _____

PARENTS' (OR GUARDIANS') NAMES:

1. MALE PARENT OR GUARDIAN _____

OCCUPATION _____ BUSINESS PHONE _____

BUSINESS ADDRESS _____

2. FEMALE PARENT OR GUARDIAN _____

OCCUPATION _____ BUSINESS PHONE _____

BUSINESS ADDRESS _____

FAMILY DOCTOR'S NAME _____ PHONE NUMBER _____

PHYSICAL DISABILITIES _____

DATE OF YOUR LAST TETANUS SHOT _____

NAMES OF TWO OTHER RELATIVES OR PERSONS TO CONTACT IN AN EMERGENCY:

1. NAME _____

ADDRESS _____ PHONE _____

2. NAME _____

ADDRESS _____ PHONE _____

HOME HIGH SCHOOL _____

ADDRESS _____

HOME SCHOOL COUNSELOR _____ PHONE _____

HOME SCHOOL PRINCIPAL _____ PHONE _____

TRADE EXPERIENCE:

ORIENTATION TO AUTO BODY
UNIT I

INFORMATION SHEET

- I. Trade and Industrial Education — Organized programs of instruction for the development of attitudes, manipulative skills, safety judgments, and technical knowledge designed to prepare individuals for gainful employment in an industrial skilled trade
- II. Guidelines for becoming a responsible auto-body technician
 - A. Operate all shop equipment and power tools safely and correctly
 - B. Be safety conscious and follow safety regulations
 - C. Accept instructions and follow directions
 - D. Show enthusiasm for work
 - E. Control temper at all times
 - F. Exhibit pride in auto-body trade
 - G. Be conscious of waste in materials and working hours
 - H. Be punctual
 - I. Practice personal hygiene
- III. Occupational outlook for auto-body technicians
 - A. Auto-body technicians are employed in every state and city in the country
 - B. Job openings will result from deaths, medical and other retirements, transfers to other fields, advanced technology, and new businesses
 - C. Number of vehicles increases each year, creating a need for more trained technicians to repair them
 - D. Specialization within the trade has created additional job opportunities
- IV. Employment opportunities for auto-body technicians
 - A. Independent auto-body shops
 - B. New and used automobile dealerships
 - C. Federal, state, and local government vehicle maintenance pools

INFORMATION SHEET

- D. Fleet maintenance pools for large industries and institutions
- E. Automotive manufacturing companies
- F. Automobile rental companies
- G. Specialized areas

EXAMPLES: Marine industry, heavy equipment construction, aircraft industry

ORIENTATION TO AUTO BODY UNIT I

ASSIGNMENT SHEET #1 — COMPLETE AN AUTO-BODY INDUSTRY SURVEY

NAME _____ SCORE _____

When you consider entering a career field, it is important that you consider a number of factors to see if you are suited for that occupation and whether the trade offers what you want from a job. You need to examine the exact nature of the work and the skills required, and you need to consider the type of training required to prepare you for the occupation. You will also want to look at pay and other benefits.

The following survey will help you examine some of these employment factors. Additionally, this contact with someone in the auto-body industry may lead to a full- or part-time job opportunity. Contact a person in the industry and complete the survey. Your instructor may provide you with names, or you may make your own contacts.

A. Contact person/business

Contact person: _____ Position: _____

Name of business: _____

Type of business: _____

Address: _____ Phone: _____

Number of employees:

Salary schedule:

Full Time _____

Full Time _____

Part Time _____

Part Time _____

B. Has firm previously employed Vo-Tech students? Yes _____ No _____

If answer is no, please explain. _____

ASSIGNMENT SHEET #1

- C. Categorize, in order of importance, areas of training stressed in program. Write a "1" before the most important area, a "2" before the next most important, and so on.

☐ Minor metal repair	☐ Refinishing
☐ Major metal repair	☐ Detailing
☐ Frame repair	☐ Customer relations
☐ Glass & panel replacement	☐ All
☐ Refinishing preparation	

- D. Would the firm be interested in employing a Vo-Tech student? Yes ☐ No ☐

- E. Which characteristics are considered mandatory for employment? Check choice(s).

☐ Good grooming habits	☐ Good personality
☐ Good work attitude	☐ All of the above
☐ Promptness	

- F. Would the contact person or business be interested in contributing to the training of Vo-Tech students? If yes, check areas.

☐ Hosting field trip to place of business
☐ Being or providing a guest speaker
☐ Providing training materials (damaged parts, etc.)
☐ Providing one day on-the-job training for a student
☐ Serving on school advisory committee

ORIENTATION TO AUTO BODY
UNIT I

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1 — Evaluated to the satisfaction of the instructor

ORIENTATION TO AUTO BODY
UNIT I

TEST

NAME _____

SCORE _____

1. Define *Trade and Industrial Education*.

2. List six guidelines for becoming a responsible auto-body technician.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

3. List three facts concerning the occupational outlook for auto-body technicians.

a. _____

b. _____

c. _____

TEST

4. Name four employment opportunities for auto-body technicians.

- a. _____
- b. _____
- c. _____
- d. _____

(NOTE: Test question 5 lists the assignment sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

5. Complete an auto-body industry survey.

ORIENTATION TO AUTO BODY
UNIT I

ANSWERS TO TEST

1. Definition should include the following — Organized programs of instruction for the development of attitudes, manipulative skills, safety judgments, and technical knowledge designed to prepare individuals for gainful employment in an industrial skilled trade
2. Answer should include any six of the following
 - a. Operate all shop equipment and power tools safely and correctly
 - b. Be safety conscious and follow safety regulations
 - c. Accept instructions and follow directions
 - d. Show enthusiasm for work
 - e. Control temper at all times
 - f. Exhibit pride in auto-body trade
 - g. Be conscious of waste in materials and working hours
 - h. Be punctual
 - i. Practice personal hygiene
3. Answer should include any three of the following
 - a. Auto-body technicians are employed in every state and city in the country
 - b. Job openings will result from deaths, medical and other retirements, transfers to other fields, advanced technology, and new businesses
 - c. Number of vehicles increases each year, creating a need for more trained technicians to repair them
 - d. Specialization within the trade has created additional job opportunities
4. Answer should include any four of the following
 - a. Independent auto-body shops
 - b. New and used automobile dealerships
 - c. Federal, state, and local government vehicle maintenance pools
 - d. Fleet maintenance pools for large industries and institutions
 - e. Automobile manufacturing companies
 - f. Automobile rental companies
 - g. Specialized areas
5. Evaluated to the satisfaction of the instructor

SAFETY AND BASIC FIRST AID UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to practice safety on the job and perform basic first-aid treatment for accident victims. The student will show this knowledge by completing assignment sheets, job sheets, and unit test with a minimum score of 100 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with safety and basic first aid.
2. State job safety rules.
3. Match colors of the safety color code to their correct applications.
4. Match classes of fires to their correct descriptions.
5. Discuss why knowledge of first aid is important.
6. Arrange in order first-aid actions to follow in an emergency.
7. List auto-body-related injuries that require the administration of first aid.
8. Discuss symptoms of traumatic shock.
9. State measures to take for prevention of heat stroke, heat cramps, and heat exhaustion.
10. Distinguish between symptoms of heat stroke and heat exhaustion.
11. Identify pressure points to use to control bleeding from various areas of the body.
12. Classify burns by degree according to their symptoms.
13. List guidelines for administering first aid to a victim with an eye injury.
14. Discuss signs and symptoms of fractures.
15. List guidelines for administering first aid to a victim with a suspected fracture.
16. Demonstrate the ability to
 - a. Perform first-aid treatment for simulated accident victims.
 - b. Properly lift a heavy object.

SAFETY AND BASIC FIRST AID
UNIT II

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Supplements
 - 1. Supplement #1 — Safety Pledge
 - 2. Supplement #2 — Safety and First-Aid Crossword Puzzle
 - 3. Supplement #3 — Chemical Chain Reaction
 - 4. Supplement #4 — Fire Extinguishment Theory
 - 5. Supplement #5 — General Directions for Giving First Aid
 - 6. Supplement #6 — How to Lift Safely
 - 7. Supplement #7 — Auto-Body-Related Hazards
 - 8. Supplement #8 — How to Beat the Heat
 - D. Transparency masters
 - 1. TM #1 — Types of Fire Extinguishers
 - 2. TM #2 — Standard Letter Symbols for Fire Extinguishers
 - 3. TM #3 — New Pictorial Symbols Used to Label Fire Extinguishers
 - 4. TM #4 — Fire Extinguisher Suitable for Class B and Class C Fires
 - 5. TM #5 — Fire Triangle
 - 6. TM #6 — Fire Tetrahedron
 - 7. TM #7 — Face and Skin Conditions in Heat Stroke and Heat Exhaustion
 - E. Information sheet
 - F. Assignment sheets
 - 1. Assignment Sheet #1 — Identify Auto-Body Shop Safety Violations
 - 2. Assignment Sheet #2 — Match Fire-Extinguisher Symbols to Given Types of Fires

SUGGESTED ACTIVITIES

3. Assignment Sheet #3 — Analyze Case Studies to Determine Correct First-Aid Treatments

G. Answers to assignment sheets

H. Job sheets

1. Job Sheet #1 — Perform First-Aid Treatment for Simulated Accident Victims
2. Job Sheet #2 — Properly Lift a Heavy Object

I. Test

J. Answers to test

II. Instructor's guide

A. Review unit and plan presentation.

B. Order or obtain materials to supplement unit.

1. Films

(NOTE: Films "e" through "l" in the following list are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these films from the Curriculum and Instructional Materials Center, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order from the addresses listed with the films.)

- a. *Housekeeping Means Safe Keeping*. Color, 10 minutes, Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

(NOTE: This film begins by taking the audience to a typical plant where they are presented with a variety of housekeeping violations. The dangers of these violations are then forcefully dramatized in the slow-motion recreation of a painful and realistic accident.)

- b. *Stop a Fire Before It Starts*. Color, 10 minutes, Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

(NOTE: In easy-to-understand laboratory demonstrations, this film shows how everyday materials become explosive in the presence of sparks, cigarettes, and so on. From the laboratory, the film moves to typical on-the-job locations where hazardous fire situations are encountered and their blazing conclusions displayed. Most importantly, viewers learn why these situations were hazardous and what could have been done to prevent these fires.)

SUGGESTED ACTIVITIES

- c. *A New Way to Lift*. Color, 9 minutes, Journal Films, Inc., 1970. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

(NOTE: This film, produced in conjunction with the National Safety Council, demonstrates body mechanics that apply to all lifting situations. By following these tips, students may avoid serious back injury.)

- d. *The Industrial Weightlifter II*. Color, 11 minutes, Ruddel Films for Industrial Accident Prevention Association, Ontario and Canada Packers, Ltd., 1981. Available from International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, Illinois 60604.

(NOTE: Visuals have been updated in this new version that illustrates correct techniques for lifting heavy objects to prevent injury.)

- e. *An Option to See*. Color, 18 minutes, Oklahoma Society to Prevent Blindness, 1977. Available from Film Library, Oklahoma State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.

(NOTE: This safety film stresses the importance of wearing safety glasses while working around machinery.)

- f. *Don't Push Your Luck*. Color, 12 minutes, Harvest Films, Inc., 1978. Available from Harvest Films, Inc., 309 Fifth Avenue, New York, New York 10016.

(NOTE: In this film Bill Frank, an actual victim, recreates his real-life blinding accident. He delivers powerful safety messages to industrial employees and shows proper eye and face protection.)

- g. *It's Up to You*. Color, 11 minutes, Harvest Films, Inc., 1960. Available from Harvest Films, Inc., 309 Fifth Avenue, New York, New York 10016.

(NOTE: This is an award-winning breakthrough film on eye safety.)

- h. *Eye Injuries*. Color, 6 minutes, International Film Bureau, 1981. Available from International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, Illinois 60604.

(NOTE: This film demonstrates the procedure for removing particles from under the eyelids.)

- i. *On Every Hand*. Color, 10 minutes, Journal Films, Inc., 1970. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

(NOTE: This film demonstrates how to avoid serious hand injuries that could be caused by commonly used and dangerous equipment.)

SUGGESTED ACTIVITIES

- j. *How to Avoid 16 Leading Causes of OSHA Citations*. Color, 20 minutes, Bureau of Business Practice, 1978. Available from Bureau of Business Practice, 24 Rope Ferry Road, Waterford, Connecticut 06386.

(NOTE: This film shows the most common OSHA violations and tells how to avoid them.)

- k. *Safety in the Shop: Basic Practices*. Black and white, 13 minutes, Coronet Films, 1970. Available from Coronet Films, 65 East South Water Street, Chicago, Illinois 60601.

(NOTE: This film emphasizes the worker's responsibility for safety in using hand and power tools. It explains the importance of a clean shop, proper clothing, correct ways to lift, and ways to guard against fires.)

- l. *Danger Zone: Your Back*. Color, 18 minutes, Visucom Productions, 1981. Available from Visucom Productions, P. O. Box 5472, Redwood City, California 94063.

(NOTE: This safety film demonstrates good lifting, pulling, and pushing practices and is designed to motivate employees to participate in accident prevention.)

- 2. Safety signs, posters, and other films or filmstrips

(NOTE: Various safety educational material and filmstrips are available from Underwriters Laboratories, Inc., Public Information and Education Services, 207 East Ohio Street, Chicago, Illinois 60611.)

- 3. Full-color transparencies from the unit "Fire Behavior" in the IFSTA manual *Essentials of Fire Fighting*

(NOTE: This box of seventeen transparencies covering the burning process includes a plastic universal mount and an interleaf of each transparency for use by the instructor in a teaching outline. This set of transparencies is available from Fire Protection Publications, Oklahoma State University, Stillwater, Oklahoma 74078, or call toll-free 800-654-4055.)

- 4. Transparencies, competency profiles, and shop safety signs

(NOTE: Transparencies, competency profiles, and shop safety signs for this book are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

- C. Provide students with unit.

SUGGESTED ACTIVITIES

- D. Introduce unit by stressing the importance of safety and first aid, particularly as related to the auto-body trade.

SUGGESTIONS:

- Stress that the type of work activities practiced by auto body-technicians are such that minor injuries such as skinned knuckles, scratches, smashed fingers, and strained muscles occur very frequently.
- Explain how safe practices and habits may prevent injuries, loss of equipment, and loss of materials; and may even save lives.
- Discuss the Good Samaritan Act. Is it active in your community? How active is it? What persons does it specifically cover?
- Use instances that you know of or have heard about, or use case studies, to point out the importance of knowing how to administer first aid.
- Have each student complete and sign a copy of Supplement #1, "Safety Pledge." Collect and file.

- E. Discuss unit and specific objectives, pointing out that the safety and first-aid material in this unit is important enough to require a score of 100 percent on the unit test.

- F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with safety and first aid.

SUGGESTIONS:

- Explain how knowing the terms and definitions will help the student understand and grasp the importance of this unit.
- Have students review terms associated with safety and first aid by completing Supplement #2, "Safety and First-Aid Crossword Puzzle."

2. Use Information Sheet, Section II to discuss job safety rules.

SUGGESTIONS:

- Discuss OSHA and other regulatory acts and agencies.
- Show films *Safety in the Shop: Basic Practices*, *Housekeeping Means Safe Keeping*, and *How to Avoid 16 Leading Causes of OSHA Citations*.
- Demonstrate any safety procedures and explain any safety policies applicable to your specific equipment or shop.

SUGGESTED ACTIVITIES

- Ask students to explain why personal and job safety rules are important. Have them list possible consequences of not following these rules.
 - Stress the consequences of practical jokes on the job. Point out that employers do not want cheerless or humorless workers, but that they do want responsible employees who know the right time and place for humor. Explain how some people have lost their jobs because they engaged in horseplay or played practical jokes during working hours.
 - Explain how horseplay and practical jokes around power equipment increase the possibility of accidents.
 - Set up work schedules and shop clean-up procedures, and explain to students. Post these schedules on the bulletin board.
 - Explain procedures for disposing of waste and scrap materials.
 - Discuss particular storage and handling procedures related to the flammable liquids used in your shop.
 - Inform students of your standards for transferring or filling containers with thinners and reducers.
 - Discuss proper use of cleaning equipment and supplies, demonstrating special cleaning procedures or techniques specific to your equipment or shop.
 - Have students practice identifying job-site and shop safety violations by completing Assignment Sheet #1.
3. Use Information Sheet, Section III to discuss the safety color code and its applications.

SUGGESTIONS:

- Ask if anyone in the class is colorblind (unable to distinguish between certain colors such as red and green). Take colorblind students on a special tour of the shop and work area, pointing out specific locations and applications for safety colors.
 - List colors of the safety color code, and have students find and list applications of each in the auto-body shop.
4. Use Information Sheet, Section IV and Transparencies #1 through #4 to discuss classes of fires and types of fire extinguishers. Stress the importance of knowing the different classes of fires and the correct type of fire extinguisher to use for each.

SUGGESTIONS:

- Have students locate and read the labels on each of the fire extinguishers in the shop area, listing the class or classes of fire each should be used on.

SUGGESTED ACTIVITIES

- Invite a fire fighter to the class to explain and to demonstrate the proper use of the various types of fire extinguishers.
 - Provide students with copies of Supplements #3 and #4 for reference. Discuss.
 - Show film *Stop a Fire Before It Starts*.
 - Use Fire Protection Services transparencies and Transparencies #5 and #6 to explain the burning process.
 - Have students practice selecting the correct fire extinguisher by completing Assignment Sheet #2.
5. Use Information Sheet, Section V to discuss the importance of knowing first-aid techniques.

SUGGESTIONS:

- Supplement your discussion with material from the American Red Cross books *Standard First Aid and Personal Safety* and *Multimedia Standard First Aid Student Workbook*. Encourage students to obtain their own copies of these manuals for home and work-site reference. Both manuals are available from the American Red Cross, 17th and D Streets, Washington, D. C. 20006.
 - Provide each student with a copy of Supplement #5 to use for quick reference.
 - Show films *An Option to See*, *Don't Push Your Luck*, *It's Up to You*, and *On Every Hand*.
6. Discuss Information Sheet, Section VI, stressing the importance of knowing the steps to follow and the correct sequence of these steps when giving first aid to an accident victim.

SUGGESTIONS:

- Invite a resource person to speak to the class on first-aid techniques.
 - Encourage students to take American Red Cross CPR and first-aid courses for certification.
 - Have students practice using appropriate first-aid techniques by completing Job Sheet #1.
7. Use Information Sheet, Section VII to discuss auto-body-related injuries that require the administration of first aid. Stress auto-body-related causes of respiratory failure/cardiac arrest and the proper procedures for lifting heavy objects.

SUGGESTIONS:

- Have students list auto-body-related causes of respiratory failure.

SUGGESTED ACTIVITIES

- Invite a resource person certified in CPR techniques to speak to the class and to demonstrate proper CPR procedure. Use Job Sheet #1 and a resuscitation doll for demonstration.
 - Have students demonstrate proper steps to follow for mouth-to-mouth resuscitation. Use Job Sheet #1.
 - Supplement discussion of respiratory failure/cardiac arrest with Red Cross CPR module "Respiratory and Circulatory Emergencies."
 - Use Supplement #6, "How to Lift Safely," to illustrate your discussion.
 - Show films, *A New Way to Lift*, *The Industrial Weightlifter II*, and *Danger Zone: Your Back*.
 - Provide students with copies of Supplement #7, "Auto-body-Related Hazards." Discuss.
 - Demonstrate procedures outlined in Job Sheet #2, and then have students complete Job Sheet #2.
8. Use Information Sheet, Section VIII to discuss traumatic shock, stressing that such shock can be life-threatening unless treated.

SUGGESTION:

- Demonstrate and discuss procedure for treating shock as outlined in Job Sheet #1. Supplement your discussion with material from the American Red Cross book *Multimedia Standard First-Aid Student Workbook*.
9. Discuss Information Sheet, Section IX, stressing prevention of heat stroke and heat exhaustion as related to conditions in the auto-body shop.

SUGGESTION:

- Discuss the need to drink plenty of water to prevent dehydration and possible heat stroke or heat exhaustion. Water is better than sweet or electrolyte drinks because water leaves the stomach faster and is more quickly available for the tissues. Discuss also the need for increasing one's salt intake and eating a balanced diet. Using a little extra table salt can help replace sodium and chloride lost through heavy perspiration. Salt tablets are not recommended. A balanced diet of whole-grain cereals, fruits, vegetables, milk, meat, poultry, and fish will supply potassium and other mineral elements lost through heavy perspiration.
10. Use Information Sheet, Section X to explain the symptoms of heat stroke and heat exhaustion.

SUGGESTIONS:

- Use Transparency #7 to illustrate your discussion.

SUGGESTED ACTIVITIES

- Make copies of Supplement #8 to post on the bulletin board or to hand out to students for future reference. Discuss.
11. Use Information Sheet, Section XI to explain the correct pressure points to use to control bleeding.

SUGGESTIONS:

- Remind students that pressure points are used only when bleeding cannot be controlled by direct pressure.
- Have students study Supplement #5, "Auto-Body-Related Hazards," to determine which situations present a bleeding hazard.
- Relate incidents from your experience, or give case studies, to illustrate the importance of controlling bleeding by direct pressure.
- Remind students that bleeding victims should be observed for signs of shock and treated accordingly.
- Explain the difference between arterial and venous bleeding: arterial bleeding is bright red and spurts or flows intermittently; venous bleeding is dark red and flows continuously. *Immediate* steps must be taken to stop arterial blood flow, as this is a life-threatening situation. Often even heavy pressure to a pressure point is ineffective in stopping arterial bleeding. In such cases, the severed artery must be found and pinched closed with the fingers. Direct pressure is usually effective in controlling venous bleeding.
- Demonstrate the steps for controlling bleeding by direct pressure outlined in Job Sheet #1. Have students practice applying pressure to simulated bleeding (both arterial and venous) on various parts of the body by completing appropriate section of Job Sheet #1.
- Caution students that tourniquets are used **ONLY** as a last resort. Explain that while a tourniquet may be necessary to save a person's life, it cuts off circulation and may cost the victim his or her limb. Stress that if a tourniquet *must* be used, the victim must be seen by a physician as soon as possible.
- Explain what to do if the victim has severed a finger, hand, or limb. Tell students that bleeding should be controlled by applying pressure to the correct pressure point, and that the severed appendage should be wrapped in a clean cloth or placed in a clean plastic bag and be transported to the hospital with the victim. If possible, the appendage should also be kept cool with ice; but the ice must not be allowed to directly touch the appendage.

SUGGESTED ACTIVITIES

12. Use Information Sheet, Section XII to discuss symptoms of first-, second-, and third-degree burns.

SUGGESTIONS:

- Stress that immediate care of a burn victim may be the deciding factor in the severity of the injury.
 - Point out situations and areas of the shop and work site that have a potential for burns.
 - Demonstrate and have students complete appropriate section of Job Sheet #1.
13. Use Information Sheet, Section XIII to discuss the administration of first aid for eye injuries.

SUGGESTIONS:

- Show film *Eye Injuries*.
 - Stress that the whole eye may be damaged in a serious injury and that vision may be lost. The sooner medical care is obtained, the greater the chances of saving the victim's sight.
 - Demonstrate and have students complete appropriate section of Job Sheet #1.
14. Use Information Sheet, Section XIV to discuss signs and symptoms of fractures.

SUGGESTIONS:

- Discuss the differences between open and closed fractures, both in treatment and signs and symptoms.
 - Remind students that when they cannot tell whether a person is suffering from a fracture or a sprain they should always assume that the injury is a fracture and treat it as such.
15. Use Information Sheet, Section XV to discuss guidelines for treating suspected fractures.

SUGGESTIONS:

- Invite a member of the local Red Cross chapter to come to class to demonstrate different types of splints and splinting techniques. Have this person also demonstrate correct procedures for immobilizing a person with a suspected neck or back fracture.

SUGGESTED ACTIVITIES

- Demonstrate and have students complete appropriate section of Job Sheet #1.

- G. Review safety rules several times during the duration of the training program.
- H. Have students complete Assignment Sheet #3.

(NOTE: Assignment Sheet #3 should be given to students only after they have reviewed the information sheet and completed the job sheets and Assignment Sheets #1 and #2. It should be treated as a practice exercise in which students apply the knowledge they have gained from the entire training program.)

- I. Post appropriate warning signs and operating procedures near equipment.
- J. Caution students that noncompliance with safety rules will result in disciplinary action.
- K. Urge students to read and use supplements furnished with this unit.
- L. Give test.
- M. Critique test and discuss in class.
- N. Reteach and retest if necessary.
- O. Complete appropriate section of competency profiles.

III. Unit references

- A. *Accident Prevention Manual for Industrial Operations*, 7th ed. Chicago, Illinois: National Safety Council, 1974.
- B. American Red Cross. *Standard First Aid and Personal Safety*, 2nd ed. Garden City, New York: Doubleday and Company, Inc., 1979.
- C. *An Accident Prevention Program for School, Shops, and Laboratories*. State College, Pennsylvania: Department of Vocational Education/Pennsylvania State University, 1967.
- D. Carlson, Gene P. and William J. Vandervort, eds. *Essentials of Fire Fighting*, 2nd ed. Stillwater, Oklahoma: Fire Protection Publications, Oklahoma State University, 1983.
- E. *Federal Register*. Vol. 36, No. 105, Pt. 2. Washington, D.C.: United States Department of Labor, 29 May 1971.
- F. *First Aid*. Washington, D. C.: United States Department of Labor, Bureau of Mines, 1978.

SUGGESTED ACTIVITIES

- G. Hendrix, Laborn J. "Bud." *Fundamentals of Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1985.
- H. *Safety Practices and Procedures in School Shops*. Trenton, New Jersey: Department of Education/Division of Vocational Education, n.d.
- I. Smith, Earl. *Power Line Technician*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — SAFETY PLEDGE

Safety Pledge

It is understood that each student/employee will be given proper instruction in the use of the equipment and in the correct safety procedures concerning the equipment before she or he will be allowed to operate it. The student/employee must assume responsibility for following safe practices. We, therefore, ask that the student/employee subscribe to the following safety pledge.

I will follow all safety rules.

I will never use a machine without first having permission from my instructor or supervisor.

I will not ask permission to use a particular machine unless I have been instructed in its use and have scored 100 percent on the safety test for that machine.

I will report immediately any accident or injury, no matter how minor, to my instructor or supervisor.

Student's/employee's signature_____ Date_____

Manager's signature_____ Date_____

Supervisor's or instructor's signature_____ Date_____

Parent's or guardian's signature_____ Date_____

(Parental consent is necessary if the student/employee is under 18.)

SUGGESTED ACTIVITIES

SUPPLEMENT #2 — SAFETY AND FIRST-AID CROSSWORD PUZZLE

Test yourself on safety and first-aid terminology by using the clues below to complete the following crossword puzzle. Clue 57 Down has been done for you.

ACROSS

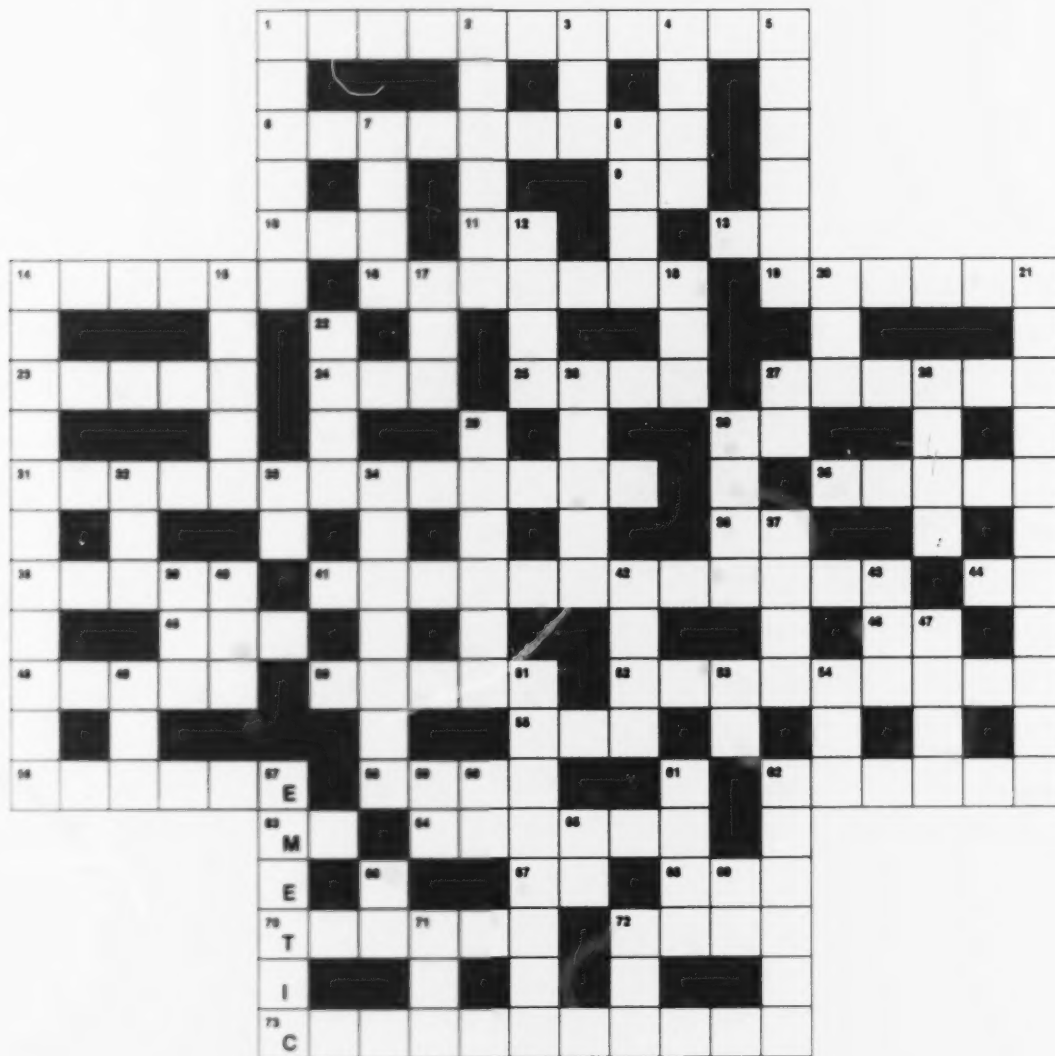
1. Guidelines for job safety (2 wds.)
6. Suddenly occurring unintentional events that cause injury or property damage
9. Exists
10. Long, thin fish
11. Northwest Territories (abbr.)
13. Atop
14. Source of danger
16. Intensity indicators for first- second- and third-
19. Muscular organ in mouth
23. Combustible substance in Class D fire
24. Cardiopulmonary resuscitation (abbr.)
25. Fracture associated with open wound
27. Explode; burst violently
30. "To be or not to . . ."
31. Act of reviving a person by bringing person back to full consciousness
35. Common blood group
36. Route (abbr.)
38. Substance in fire extinguisher used on Class A and Class B fires
41. Negligence; failure to think before one acts
44. 101 Roman
45. Word of negation
46. Pennsylvania (abbr.)
48. Federal safety color designating location of first-aid equipment
50. Indication of fire
52. Capable of being easily ignited
55. Untruth
56. Life-threatening disorder caused by prolonged exposure to intense heat
58. Tender; painful
62. Freedom from danger, risk, or injury
63. Physician's degree
64. Resuscitate
67. Article
68. Health resort with mineral springs
70. Complaint of victim in shock from hemorrhage
72. Wound made by piercing with a sharp instrument
73. Capable of bursting into flames

DOWN

1. What all metal containers for flammable materials should be
2. "Good —s to all"
3. The worst thing to do if your clothing or hair catches fire
4. Shock can be caused by — of blood
5. Device to prevent fractured bones and adjacent joints from moving
7. Water temperature for treatment of second-degree burn
8. To become in need of rest; to become weary
12. Group of three
14. Heavy loss of blood
15. Guidelines
17. Organ of hearing
18. Cause of 56 Across
20. Flammable liquid
21. Violently and loudly
22. 1151 Roman
26. What one should never do to an open fracture
27. State-of-being verb
28. — up spills immediately
29. Long, thin mark of different color than surrounding area
30. Injury caused by contact with heat, steam, electricity, or flame
32. Spanish word for 18 Down
33. Cubic centimeter (abbr.)
34. Bodily injuries, wounds, or shock
37. Group that works together toward a common goal
39. Unit
40. Prefix meaning *not*
42. Free of danger; secure
43. Identical twin of 68 Across
47. Capable
49. Ever (poetic)
51. Raises, as for an injured or bleeding limb
53. Fire extinguisher to use on flammable liquids and ordinary combustibles
54. Actress Farrow
57. Substance used to cause vomiting of some poisons
59. Either —; neither, nor
60. Prefix meaning *again*
61. Inactivity after work or exertion
62. Not changing
65. Within; inside
66. Prefix meaning *two*
69. Father (slang)
71. Action that eases heat cramps
72. Science fiction; —fi

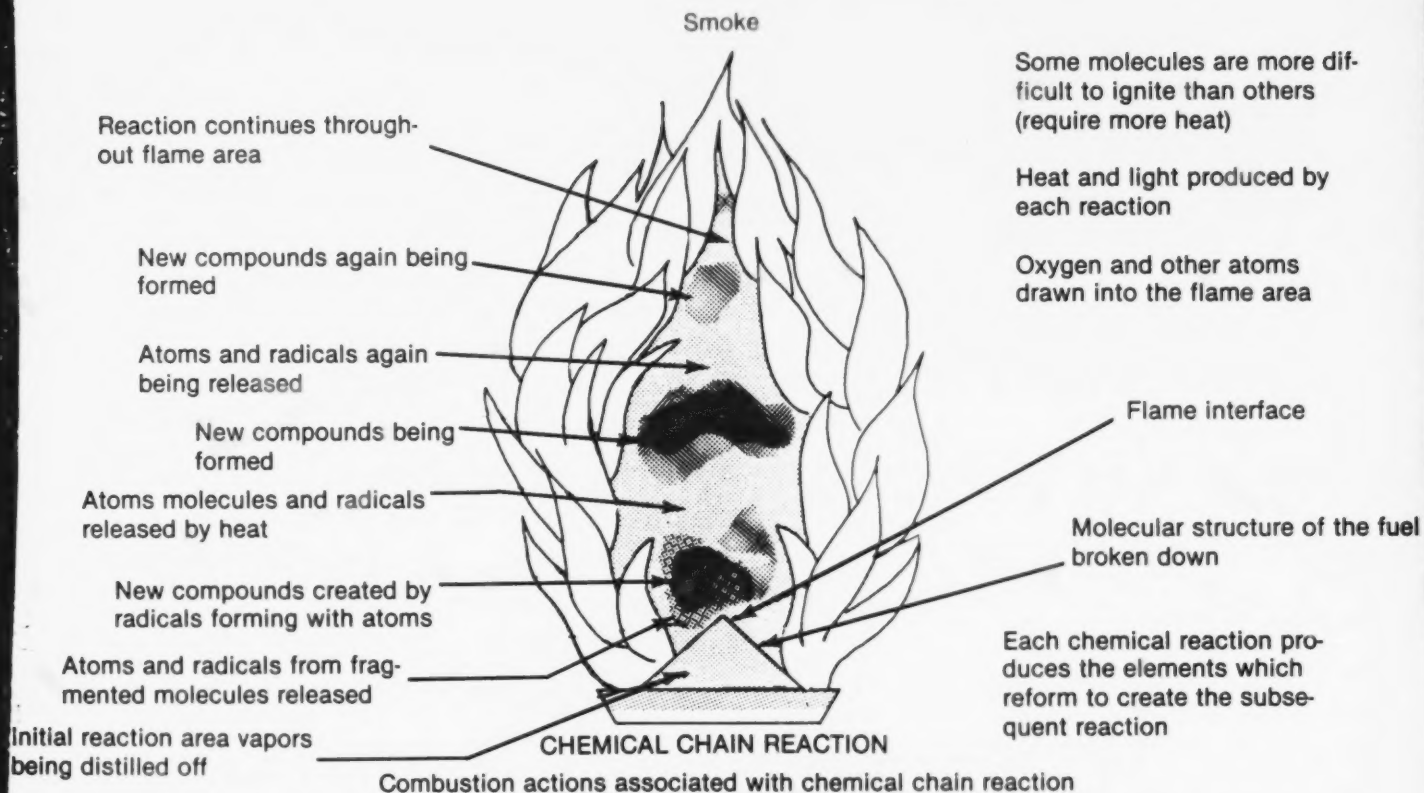
SUGGESTED ACTIVITIES

SUPPLEMENT #2



SUGGESTED ACTIVITIES

SUPPLEMENT #3 — CHEMICAL CHAIN REACTION



Used with permission of the Board of Regents, Oklahoma State University, Stillwater, Oklahoma from *Essentials of Fire Fighting*, 2nd edition, Gene P. Carlson and William Vandevort, eds., 1983.

SUGGESTED ACTIVITIES

SUPPLEMENT #4 — FIRE EXTINGUISHMENT THEORY

The extinguishment of a fire is based on the interruption of one or more of the essential elements in the combustion process. Generally, four methods may be used to extinguish fire.

1. **Reduction of temperature** — Fuel is cooled to the point where it does not produce sufficient vapor to burn; the most common cooling agent is water, which also converts to steam and smothers the fire
2. **Removal of fuel** — Flow of liquid or gaseous fuel is stopped, or solid fuel is removed from the path of the fire; fuel may also be allowed to burn until all fuel is consumed
3. **Exclusion of oxygen** — Oxygen concentration in the fire area is reduced, an inert gas is introduced, or oxygen is separated from the fuel

(NOTE: This method of extinguishment does not work on self-oxidizing materials or on certain metals as they are oxidized by carbon dioxide or nitrogen—the two most common extinguishing agents.)

4. **Inhibition of chain reaction** — Flame-producing chemical reaction is interrupted with the use of such extinguishing agents as dry chemicals or halons

(NOTE: Chemical flame inhibition is effective only on gas or liquid fuels because they cannot burn in the smoldering mode of combustion. Carbon dioxide does not interrupt chemical reaction; it extinguishes by removing oxygen.)

SUGGESTED ACTIVITIES

SUPPLEMENT #5 — GENERAL DIRECTIONS FOR GIVING FIRST AID



Keep the injured person lying down.



Do not give liquids

to an unconscious person.



Restart breathing with mouth-to-mouth

artificial respiration.



Control bleeding by pressing on the wound.



Dilute swallowed poisons



and call the Poison

Control Center. Keep broken bones from moving.



Cover burns

with thick layers of cloth.



Keep heart-attack cases quiet and give

cardiopulmonary resuscitation (CPR) if it is necessary



and if you

have been trained. Keep a fainting victim lying flat.



For eye injuries, pad and bandage both eyes.



Always call a doctor.

For more information about these and other lifesaving techniques, contact your Red Cross chapter.

American Red Cross poster

SUPPLEMENT #5

Emergency Telephone Numbers

Rescue Squad _____

Fire Department _____

Police _____

Physician _____

Hospital Emergency
Room _____

Poison Control
Center _____

Additional Numbers _____

When you call for emergency help, tell:

1. WHERE the emergency situation is, with cross streets if possible.
2. TELEPHONE NUMBER you are calling from.
3. WHAT HAPPENED—heart attack, auto accident, fall, etc.
4. HOW MANY persons need help.
5. WHAT is being done for the victims.

NOTE: YOU HANG UP LAST. Let the person you called hang up first.

Record and post emergency telephone numbers in advance so that they will be readily available when you need them.

The programs of the American Red Cross are made possible by the voluntary services and financial support of the American people.

Poster 1023-A
Rev. Mar. 1983

American Red Cross poster

HOW TO LIFT SAFELY

The following safe practices should be observed in order to avoid injury.

The factors that contribute to safe lifting are...



1. Approach the load and size it up (weight, size and shape.) Consider your physical ability to handle the load.



2. Place the feet close to the object to be lifted 8 to 12 inches apart for good balance.



3. Bend the knees to the degree that is comfortable and get a good handhold. Then using both leg and back muscles...



4. Lift the load straight up—smoothly and evenly. Pushing with your legs, keep load close to your body.



5. Lift the object into carrying position, making no turning or twisting movements until the lift is completed.



6. Turn your body with changes of foot position after looking over your path of travel making sure it is clear.



7. Setting the load down, is just as important as picking it up. Using leg and back muscles, comfortably lower load by bending your knees. When load is securely positioned, release your grip.



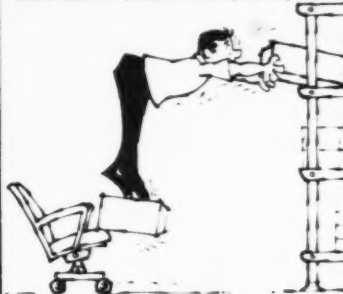
Avoid strain by storing heavy objects at least 12 inches above the floor.



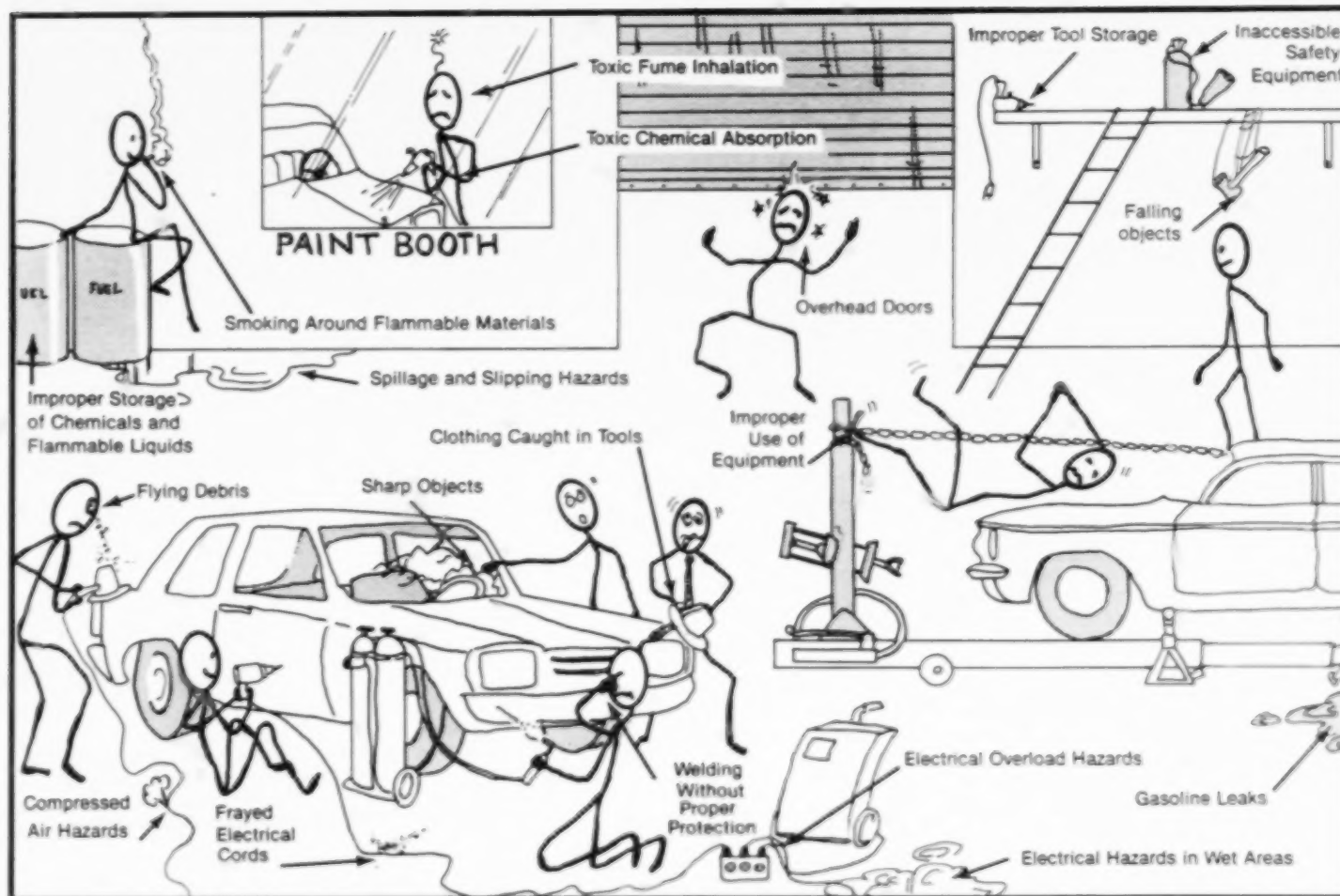
Avoid awkward positions or twisting movements while lifting.



Over-reaching and stretching to reach overhead objects may result in strains or falls. Use a ladder instead of chairs, boxes, etc.

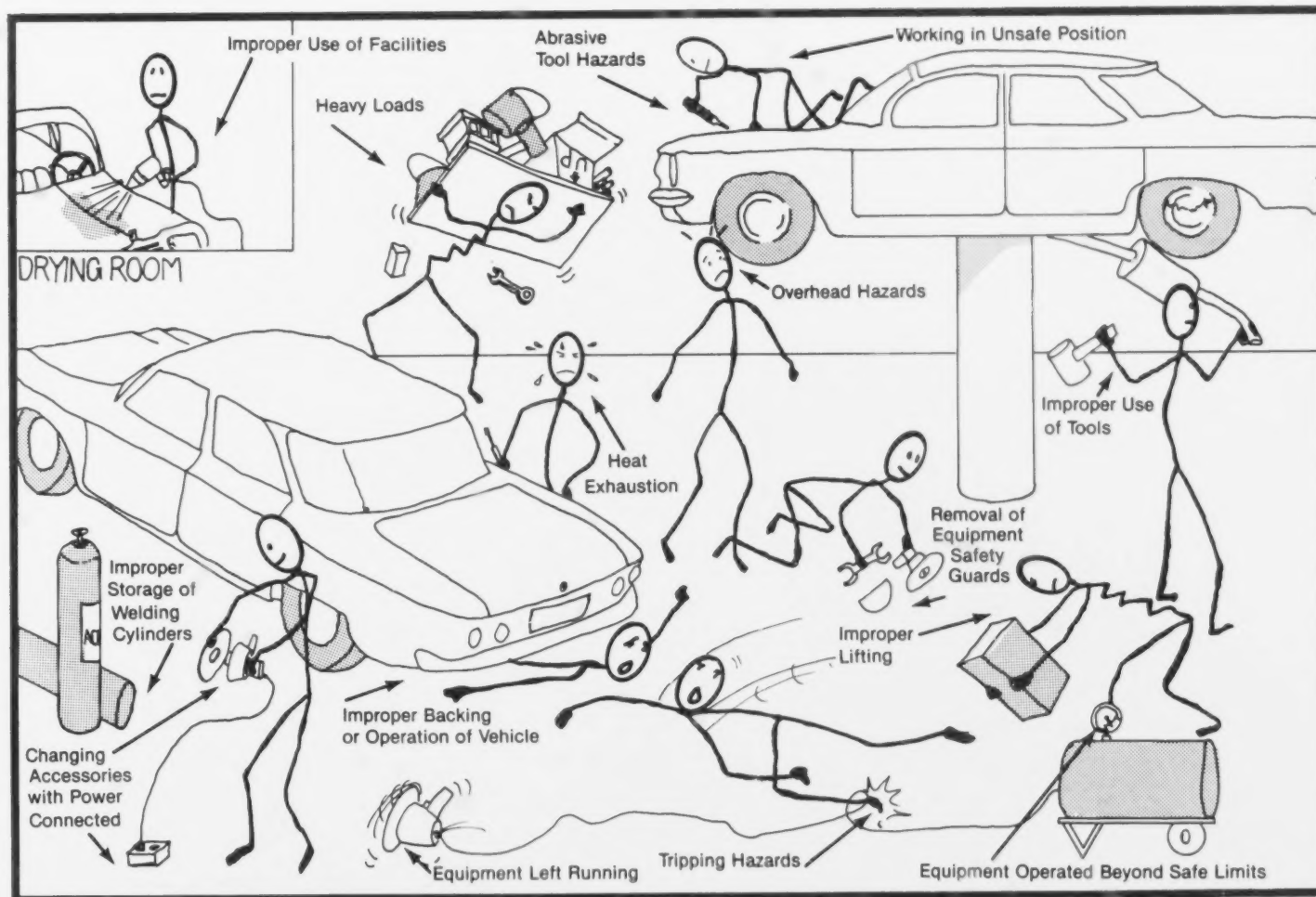


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SUGGESTED ACTIVITIES

SUPPLEMENT #7



SUGGESTED ACTIVITIES

SUPPLEMENT #8 — HOW TO BEAT THE HEAT

HOW TO BEAT THE HEAT

Reactions to hot weather vary with a person's age, general physical condition, and activity level. Older people, small children and very active young people are the most likely to suffer from heat illness.

The human body is capable of adapting itself to varying temperature conditions, but the combined effect of heat and heavy physical exertion may be too much for the body's natural temperature regulator. Heat can make some people sick, and in some cases, it can kill.

Here's what happens. The body itself produces metabolic heat — more heat when you're working or playing than when resting. Outdoors on a sunny day, radiant energy adds heat to the body. If the air is warmer than the body temperature, more heat may be added.

The body's heat regulation system tries to maintain a fairly constant temperature of about 98°F. To cool the body, the heart pumps blood out to the extremities—arms and legs—where the heat is dispersed. Another way the body eliminates heat is through the cooling evaporation of sweat. A cool breeze and low humidity help body cooling. High humidity interferes with sweating and adds to discomfort.

Some of the more common forms of heat illness are as follows:

HEAT SYNCOPY OR HEAT FAINTING

This is common among people who are not acclimated to hot weather. It normally occurs soon after someone goes out into the heat to work or exercise. The blood pressure falls suddenly as blood flows to the extremities to cool the body and not enough goes to the head. The person feels giddy, light headed and then passes out. The best first aid is to have the person lie down to rest and elevate the feet.

HEAT CRAMPS

These muscular cramps result from exposure to high temperatures for a relatively long period of time, coupled with physical exertion. Heavy sweating and dehydration usually precede the cramps.

HEAT EXHAUSTION

This occurs after some hours in the sun and is related to loss of water and salt through sweating without sufficient fluid replacement. Common symptoms include a subnormal body temperature; pallor; dizziness; profuse sweating; cool, moist skin; nausea and headaches. The best first aid is to have the person rest in a cool place and drink water or fruit juice. If the person doesn't feel better in an hour or two or can't hold liquids, take him/her to a hospital emergency room.

HEAT STROKE

This condition can prove to be fatal, so immediate medical attention is necessary. It is caused by a complete breakdown of the body's heat regulating system, with heat production exceeding heat loss. Common symptoms include hot, dry skin, little or no sweating, severe headache, visual disturbance, rapid temperature rise, loss of consciousness, flushed face, weakness and confusion.

First aid treatment should be aimed at cooling the body quickly and getting the victim to the hospital. Remove the person from the source of heat, loosen the clothing, and try to cool the body as rapidly as possible, using a cool bath or cold compresses. Don't give water to a heat stroke victim.

So when the temperatures begin to soar upward, take a few precautions to minimize your body's level of heat stress:

- Try to take frequent rest periods.
- Space heavier workloads or workouts throughout the day, rather than concentrating them in a few consecutive hours.
- Avoid heavy activity during the hottest part of the day.
- Drink plenty of water or other fluids.
- Wear loose, light clothing that reflects the sun's rays and allows sweat to evaporate. A hat will add further protection.

Coping with summer heat is just a matter of using common sense.

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Types of Fire Extinguishers

KIND OF FIRE		APPROVED TYPE OF EXTINGUISHER					
DECIDE THE CLASS OF FIRE YOU ARE FIGHTING. . .	THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS	MATCH UP PROPER EXTINGUISHER WITH CLASS OF FIRE SHOWN AT LEFT Important: Using the wrong type extinguisher for the fire may be dangerous					
		CARBON DIOXIDE Carbon Dioxide Gas Under Pressure	PUMP TANK Plain Water	MULTI-PURPOSE DRY CHEMICAL	ORDINARY DRY CHEMICAL	HALON	DRY POWDER
 CLASS A FIRES Use These Extinguishers ORDINARY COMBUSTIBLES •Wood •Paper •Cloth, etc.							
	 CLASS B FIRES Use These Extinguishers FLAMMABLE LIQUIDS, GREASE •Gasoline •Paints •Oils, etc.						
	 CLASS C FIRES Use These Extinguishers ELECTRICAL EQUIPMENT •Motors •Switches, etc.						
	 CLASS D FIRES Use This Extinguisher COMBUSTIBLE METALS •Iron •Magnesium						

Adapted with permission of American Association for Vocational Instructional Materials, Athens, Georgia, from *Developing Shop Safety Skills* by Clinton O. Jacot and J. Howard Turner, 1981.

Standard Letter Symbols for Fire Extinguishers

GREEN	RED	BLUE	YELLOW
			
ORDINARY COMBUSTIBLES	FLAMMABLE LIQUIDS	ELECTRICAL EQUIPMENT	COMBUSTIBLE METALS

Distinctive letters, shapes, and colors mark extinguishers according to the classes of fires on which they should be used.

New Pictorial Symbols Used to Label Fire Extinguishers

Symbols with blue backgrounds indicate fire extinguisher can be used for class of fire portrayed.

 TRASH•WOOD•PAPER



 LIQUIDS•GREASE



 ELECTRICAL EQUIP

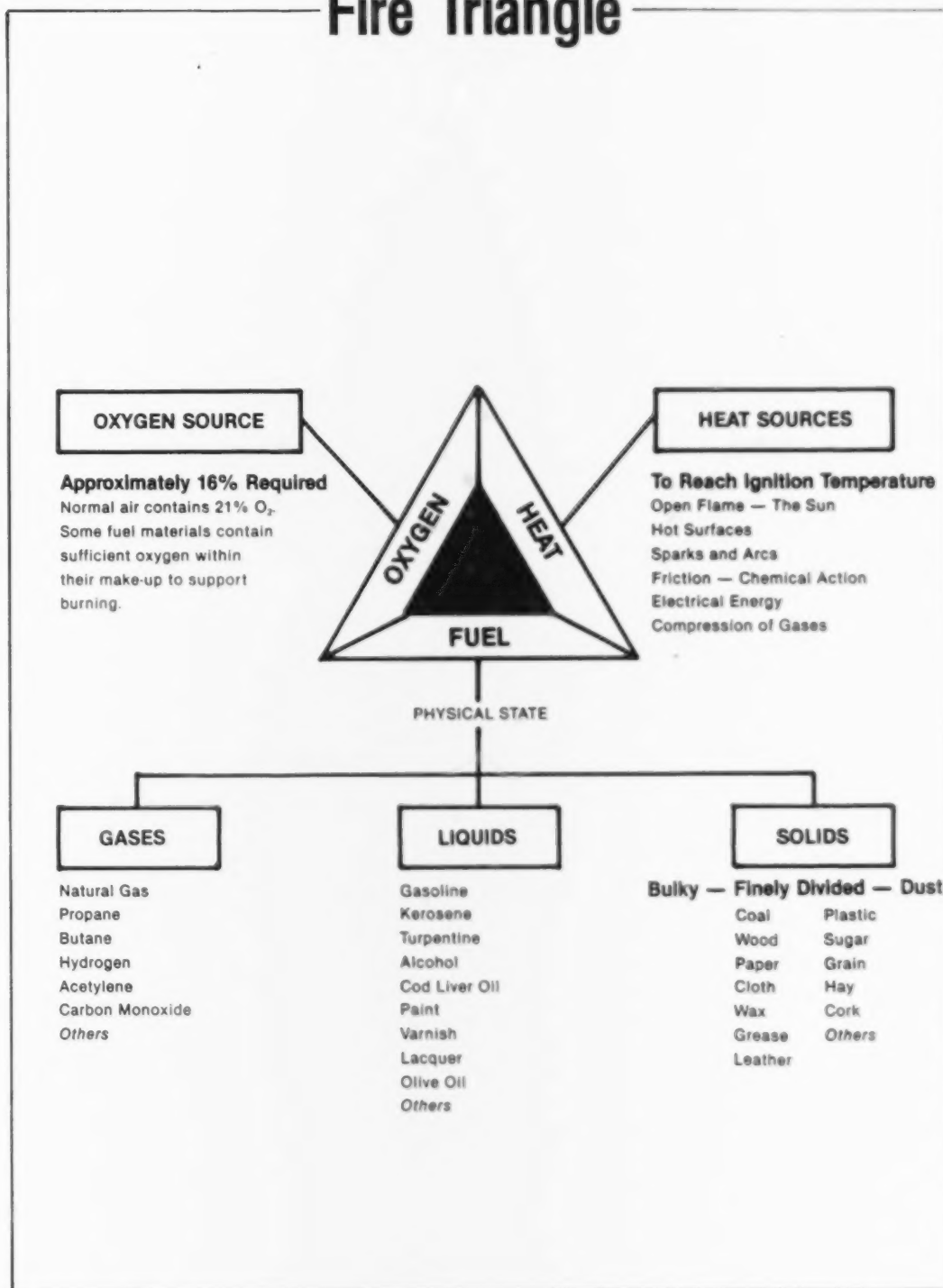


Symbols with red line across a black background indicate fire extinguisher *cannot* be used for class of fire portrayed.

Fire Extinguisher Suitable for Class B and Class C Fires

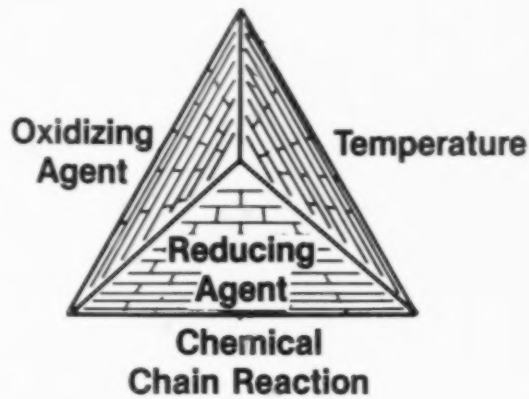
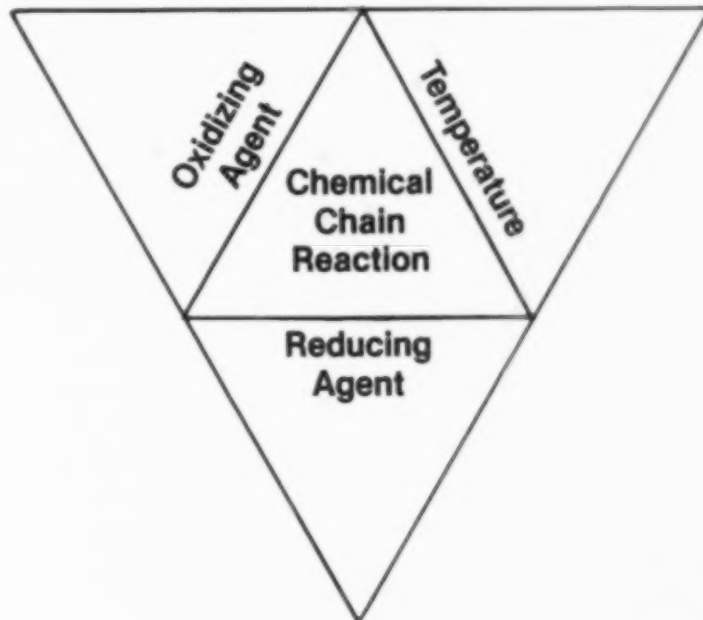


Fire Triangle



Used with permission of the Board of Regents, Oklahoma State University, Stillwater, Oklahoma, from *Essentials of Fire Fighting*, 2nd edition, Gene P. Carlson and William J. Vandevort, eds., 1983.

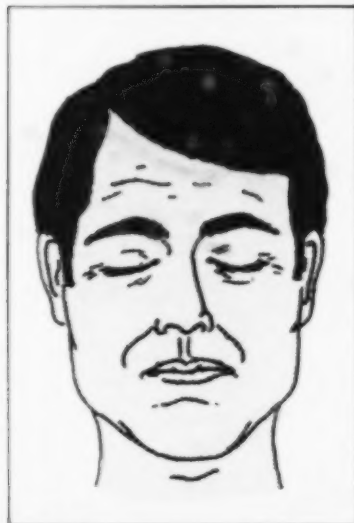
Fire Tetrahedron



Adapted with permission of the Board of Regents, Oklahoma State University, Stillwater, Oklahoma, from *Essentials of Fire Fighting*, 2nd edition, Gene P. Carlson and William J. Vandevort, eds., 1983.

Face and Skin Conditions in Heat Stroke and Heat Exhaustion

Heat Stroke

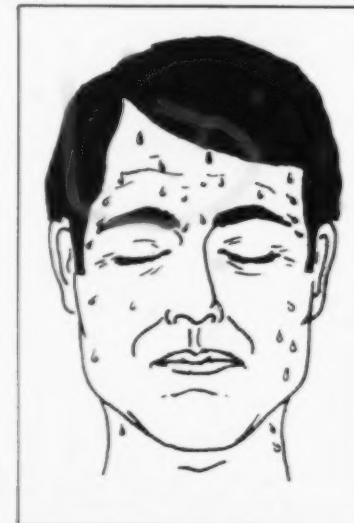


Skin Condition

Hot Red Dry

Cool body quickly.
Get immediate medical help.

Heat Exhaustion



Skin Condition

Clammy Pale Heavy Sweating

Get victim out of sun and heat, elevate
feet, cool body, give sips of salt water.

SAFETY AND BASIC FIRST AID
UNIT II

INFORMATION SHEET

I. Terms and definitions

- A. Safety — Freedom from danger, risk, or injury
 - B. First aid — Immediate, temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained
 - C. Accident — Any suddenly occurring, unintentional event that causes injury or property damage
 - D. Hazard — Source of danger
 - E. Carelessness — Negligence; failure to think before one acts, or failure to pay attention
 - F. Flammable — Capable of being easily ignited and burning with extreme rapidity
 - G. Explosive — Tending to blow up or burst violently and loudly
 - H. Combustible — Capable of bursting into flames
 - I. Extinguish — To put out a fire; to quench or smother
 - J. Pressurized — Stored under pressure greater than the pressure of the atmosphere
 - K. Resuscitation — Act of reviving a person by bringing the person back to full consciousness
 - L. Traumatic shock — Depressed condition of many of the body functions due to failure of enough blood to circulate through the body following serious injury
 - M. Tourniquet — Any device, such as a bandage and stick, used to compress a blood vessel to stop bleeding or to control blood flow
- (NOTE: Tourniquets are used *only* for severe, life-threatening hemorrhage that cannot be controlled by any other means.)
- N. Hemorrhage — Heavy loss of blood
 - O. Closed fracture — Broken bone beneath the skin with no open wound
 - P. Open fracture — Broken bone associated with an open wound

EXAMPLES: Broken bone end tears through skin, machinery penetrates skin and breaks one or more bones

INFORMATION SHEET

II. Job safety rules

A. General

1. Be familiar with location of fire-fighting and first-aid equipment
2. Be alert and conduct yourself in a manner that will ensure safe practices
3. Be conscious of others' safety
4. Report all accidents to the supervisor, regardless of nature or severity

B. Dress

1. Wear close-fitting clothing appropriate for activity being performed
2. Wear safety glasses in the shop area at all times
3. Confine long hair before operating power equipment
4. Wear goggles, apron, safety shoes, gloves, ear protection, and respiratory equipment when required

(NOTE: When working in an area at which welding is being performed, never look at welding flash, arc, or reflection without welding goggles. Irreversible damage to the retina can occur.)

5. Remove rings and other jewelry when working
6. Do not carry sharp tools in pockets

C. Equipment and tools

1. Obey all safety rules, and observe limitations on equipment according to specifications and manufacturer's requirements
2. Keep all tools sharp and clean, in safe working order, and properly stored when not in use
3. Retain guards and safety devices on all equipment
4. Tag and report to the supervisor any defective tools, machines, or other equipment
5. Be sure to shut off all power equipment when finished with it, and do not leave equipment until it has stopped completely
6. Operate equipment *only after* receiving instructions on how to operate it safely

INFORMATION SHEET

7. Disconnect power from equipment before changing accessories and before performing service or maintenance on it
8. Use the correct tool for the job
9. Clean debris from sanders, grinders, and other equipment with a brush, not with your hands or a rag; *do not* clean equipment while it is running
10. Position proper supporting devices under heavy objects and elevated vehicles
11. Follow safety rules furnished with and concerning pneumatic (air-powered) equipment
12. Never use compressed air to clean yourself or your clothing

D. Work area

1. Arrange equipment to permit safety-efficient work practices and ease of cleaning
2. Store materials and supplies safely in their proper places
3. Store tools and accessories safely in cabinets, on racks, or in suitable storage areas
4. Keep work area clear of debris and other hazards
5. Clean floors of obstructions and slippery substances; clean up spills immediately
6. Keep aisles, exits, and traffic areas free of materials and debris
7. Dispose of combustible materials properly
8. Keep sufficient brooms, brushes, waste containers, and other housekeeping equipment readily available

E. Flammable liquids and toxic substances

1. Carefully read labels on all flammable liquids, and use only in open, well-ventilated areas
2. Be cautious of inhaling or igniting fumes from flammable liquids and toxic substances
3. Be sure that all flammable liquids are marked correctly for storage

INFORMATION SHEET

4. Store all flammable liquids properly in approved safety containers
(NOTE: Oily rags and flammable materials should be stored in metal containers with self-sealing lids.)
5. Immediately change clothing soaked by flammable liquids
6. Use flammable liquids only for their intended purposes
EXAMPLE: Never use gasoline as a cleaner.
7. Do not use flammable liquids near fire or flame
8. Always know location of appropriate fire extinguisher
9. Stop, drop, and roll if your hair or clothing catches fire; *never* run

F. Vehicles

1. Use caution to prevent contact with hot manifolds and hoses
2. Be sure that vehicle engine is out of gear before starting
3. Always keep appropriate fire extinguisher near when starting and operating vehicle
4. Do not pour gasoline into carburetor or cylinder head when starting engine
5. Never pour gasoline into fuel tank when engine is hot or when engine is running
6. Do not operate vehicle that is leaking gasoline

III. Colors and applications of the safety color code

A. Federal safety red

1. Designates danger
2. Identifies fire-protection equipment and its location
3. Identifies portable containers of flammable liquids
4. Identifies emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

B. Federal safety yellow

1. Designates caution and marks physical hazards

EXAMPLES: Low beams, protruding extensions, steps

INFORMATION SHEET

2. Designates waste containers for explosive or combustible materials
3. Designates caution against starting, using, or moving equipment while it is under repair, and against the use of defective equipment
4. Identifies the starting point or power source of machinery

C. Federal safety orange

1. Designates dangerous parts of equipment that may cut, crush, shock, or otherwise injure
2. Designates safety starter buttons and parts of equipment that may cause electrical shock
3. Designates exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

D. Federal safety purple (or black or magenta on safety yellow) — Designates radiation hazards

E. Federal safety blue

1. Designates caution against and provides information about machines or equipment out of order or under repair
2. Identifies out-of-order signs on equipment

F. Federal safety green

1. Designates location of safety equipment other than fire-fighting equipment
2. Designates location of first-aid equipment

G. Federal safety black and white (used individually or in combination)

1. Designates traffic flow
2. Designates items for housekeeping purposes
3. Designates storage areas

IV. Descriptions of classes of fires

(NOTE: Fire extinguishers are labeled according to the class or classes of fires on which they may be used, the class letters prominently displayed in distinctive shapes and colors. Most new extinguishers also contain pictorial labels depicting the class or classes of fires on which the extinguisher may and may *not* be used.)

INFORMATION SHEET

- A. Class A — Fires that occur in ordinary combustible materials such as wood, rags, rubber, and plastics
 - B. Class B — Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners
 - C. Class C — Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring
 - D. Class D — Fires that occur with combustible metals such as iron, magnesium, sodium, and potassium
- V. Why knowledge of first aid is important
- A. May mean the difference between life and death
 - B. May mean the difference between temporary and permanent disability
 - C. May mean the difference between rapid recovery and long hospitalization
 - D. Prepares one for what to do and what not to do in an emergency
 - E. Promotes safety awareness
- VI. First-aid actions to follow in an emergency

(NOTE: When you give first aid, you deal with the victim's physical condition, the victim's emotional state, and the whole accident situation. First aid also includes care needed later if medical help is delayed or is not available. Urgent care is first aid given in life-threatening situations. These situations include stopped breathing, heart attack and stroke, heavy bleeding, poisoning, and shock. The actions listed below are from the Red Cross book *Standard First Aid and Personal Safety* and are given in the order in which you might take them in an emergency.)

- A. Rescue victim and yourself
- B. Restore or maintain breathing and heartbeat
- C. Control heavy bleeding
- D. Treat for poisoning

(NOTE: A poison is any substance—solid, liquid, or gas—that impairs health or causes death when introduced into the body or onto the skin surface.)

- E. Prevent shock
- F. Examine victim carefully

INFORMATION SHEET

- G. Seek medical help
 - H. Keep checking and assisting victim until medical help is obtained
- VII. Auto-body-related injuries that require the administration of first aid
- A. Bleeding
 - EXAMPLES: Cuts, punctures, scrapes, severed fingers or limbs
 - B. Chemical burns
 - EXAMPLES: Skin contact with harsh chemicals such as cleaning solvents, paints, thinners, reducers, strong detergents; skin contact with corrosive poisons such as battery acid, adhesives, reducers, and some glues
 - C. Electrical burns
 - EXAMPLES: Contact with electricity from electrical outlets, power tools, or vehicle's electrical system
 - D. Poisoning
 - (NOTE: The three ways that poisoning is most likely to occur in the auto-body shop are by inhalation, absorption, or ingestion [mouth].)
 - EXAMPLES: Inhalation of toxic vapors, gases, or mists due to improper respirator fit or use of wrong filter in respirator; absorption of toxic substance due to improper handling of spray equipment; ingestion of harsh chemicals or corrosive poisons (battery acid) due to wiping mouth after contact with such poisons
 - E. Loss of consciousness
 - EXAMPLES: Blow to the head, inhalation of toxic fumes, heat-related distress
 - F. Respiratory failure/cardiac arrest
 - EXAMPLES: Obstruction of the air passages or inhalation of toxic gases, mists, or vapors; explosion, electrocution, circulatory collapse (shock); heart attack; compression of the chest (caused, for example, by a vehicle or piece of equipment falling on victim)
 - G. Eye injuries
 - EXAMPLES: Foreign objects or substances, welding burns, cuts, punctures

INFORMATION SHEET

H. Muscle and ligament strain or sprain

(NOTE: Muscle injuries, especially to the back, usually result from improper lifting.)

I. Broken bones

(NOTE: Injuries to the skeletal system are common in all types of major accidents.)

VIII. Symptoms of traumatic shock

(NOTE: Injury-related or traumatic shock can occur to some degree with any injury. It can threaten life even though the victim's injuries may not otherwise be fatal. The three objectives in treating shock are 1] to improve circulation of the blood, 2] to ensure an adequate supply of oxygen, and 3] to maintain normal body temperature.)

A. Early stages

1. Pale or bluish skin that is cold to the touch
2. Moist, clammy skin if perspiration has occurred
3. Weakness
4. Rapid pulse (over 100 beats/minute), often too faint to be felt in wrist but perceptible in carotid artery at side of neck or femoral artery at groin
5. Increased rate of breathing that may be shallow or possibly deep and irregular
6. Restlessness, anxiousness, severe thirst if victim is in shock from hemorrhage
7. Vomiting or nausea

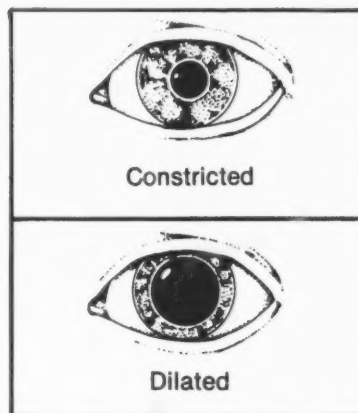
B. Late stages

1. Apathy and relative lack of responsiveness
2. Sunken eyes with vacant expression and widely dilated pupils (See Figure 1.)

INFORMATION SHEET

EXAMPLE:

FIGURE 1



3. Mottled appearance to skin, indicating that victim's blood pressure has fallen to a very low level
 4. Loss of consciousness, low body temperature, and death if untreated
- IX. Measures to take for prevention of heat stroke, heat cramps, and heat exhaustion
- A. Drink plenty of fluids
 - B. Increase salt intake
 - C. Do not overexert
 - D. Wear lightweight clothing that allows sweat to evaporate
 - E. If outdoors, keep head covered and face shaded
 - F. Take frequent short work breaks
 - G. Rest in the shade or an air-conditioned room whenever possible
- X. Symptoms of heat stroke and heat exhaustion
- A. Heat stroke — Flushed, hot, dry skin and high body temperature

(NOTE: Heat stroke is an immediate, life-threatening emergency urgently requiring medical attention. The main symptoms of heat stroke are listed above, but other symptoms may include dizziness, nausea, headache, rapid pulse, offensive body odor, and unconsciousness.)

INFORMATION SHEET

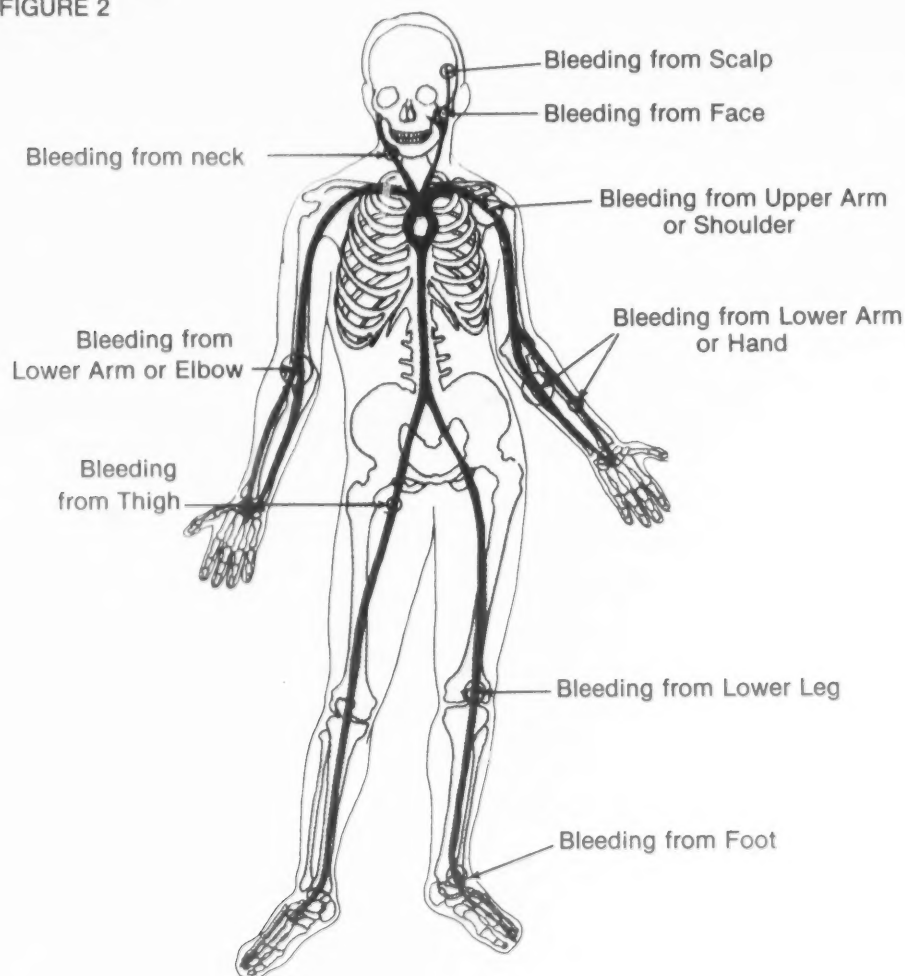
B. Heat exhaustion — Pale, cool, clammy skin and normal body temperature

(NOTE: Heat exhaustion is a much less dangerous condition than heat stroke. Symptoms, in addition to the main ones listed above, may include heavy sweating, extreme tiredness or weakness, headache, vomiting, and fainting. Heat cramps in the abdomen or legs may accompany or precede heat exhaustion.)

XI. Pressure points to use to control bleeding from various areas of the body (Figure 2)

(NOTE: Because direct pressure stops circulation only at the wound, it is better to control bleeding through the use of direct pressure than it is to use a pressure point or a tourniquet. Do not use a pressure point for an arm or leg wound unless direct pressure and elevation do not stop the bleeding. Always release the pressure point gradually when bleeding has been brought under control.)

FIGURE 2



INFORMATION SHEET

XII. Symptoms of first-, second-, and third-degree burns

A. First-degree burns

(NOTE: First-degree burns can be caused by sunburn, light contact with hot objects, accidentally touching a hot engine component, or contact with hot water or scalding steam from a radiator.)

1. Redness or discoloration
2. Mild swelling and pain
3. Rapid healing

B. Second-degree burns

(NOTE: Second-degree burns can be caused by contact with hot liquids [radiator water], mild electrical burns, or by a deep sunburn.)

1. Pain greater than that caused by first-degree burn
2. Damage extending into first layer of tissue
3. Mottled or red areas
4. Blistering
5. Considerable swelling
6. Wet appearance of burned area due to loss of plasma

C. Third-degree burns

(NOTE: Third-degree burns can be caused by flame, ignited clothing, hot objects, acid, electricity, or immersion in hot water.)

1. Deep tissue destruction
2. Less pain because of nerve destruction

(NOTE: Pain may be greatly diminished because nerve tissue has been burned.)

3. Charred or white appearance of burned area

XIII. Guidelines for administering first aid to a victim with an eye injury

(NOTE: Extreme care should be taken in administering first aid for injuries of the eye. The eye is very sensitive and can easily be damaged further if the correct first-aid methods are not carried out.)

- A. Do not let victim rub the eye

INFORMATION SHEET

- B. Do not attempt to remove a foreign object by using any sharp object

EXAMPLES: Tweezers, toothpick

- C. Keep victim flat on back if injury is caused by a penetrating object or a severe blow

(NOTE: For cuts and punctures of the eye or eyelid, get medical help at once. *Do not* wash out eye with water. *Do not* try to remove an object stuck in the eye.)

- D. Cover eye with a clean dressing if foreign object is lodged in eye and cannot be removed easily by flushing with water or by using a clean cloth

(NOTE: Flushing of eye should be done with extreme care to avoid further injury, infection, or contamination to the other eye.)

- E. Immediately flood chemical substances in eye with water

XIV. Signs and symptoms of fractures

(NOTE: An accurate diagnosis of a fracture can be made only by a physician with the assistance of an x-ray examination. The first-aid worker should *suspect* that a bone is broken. Even if there is doubt, if any one of the signs or symptoms is present, the first-aid worker should carry out first-aid measures for a fracture.)

- A. Victim's account of accident

EXAMPLES: May have heard or felt a bone snap
May indicate location of pain and tenderness and difficulty moving injured part
May report grating sensation of broken bones rubbing together
May report abnormal or false movement in suspect area

- B. Differences in shape and length of corresponding bones on the two sides of body

- C. Obvious deformities

- D. Swelling

- E. Discoloration

- F. Pain or tenderness to touch

XV. Guidelines for administering first aid to a victim with a suspected fracture

(NOTE: The objectives for administering first aid for fractures include 1] providing necessary first-aid care, 2] preventing broken bone ends and adjacent joints from moving, and 3] giving care for shock.)

INFORMATION SHEET

- A. Prevent motion of injured parts and adjacent joints
- B. When an injured person obviously requires hospitalization and an ambulance is on the way, do not attempt to move victim unless there is a life-threatening emergency

EXAMPLES: Danger of fire, carbon monoxide poisoning, explosion

- C. Give priority to open fractures over closed fractures unless associated injuries dictate otherwise
- D. Never test fracture by having the victim move the part or try to walk on a possibly broken leg
- E. Never attempt to set or reduce a fracture or try to push a protruding bone end back in place
- F. If possible, take time to tie victim's injured leg to uninjured one, or to bind injured arm to chest or side
- G. Do not allow victim to move the head (or do not move it yourself) when there is a possible neck or spine fracture
- H. Lift and move an unconscious victim as though the injury is to the neck or spine—provide rigid support for victim's back and head
- I. After providing urgent care, treat to prevent shock

SAFETY AND BASIC FIRST AID
UNIT II

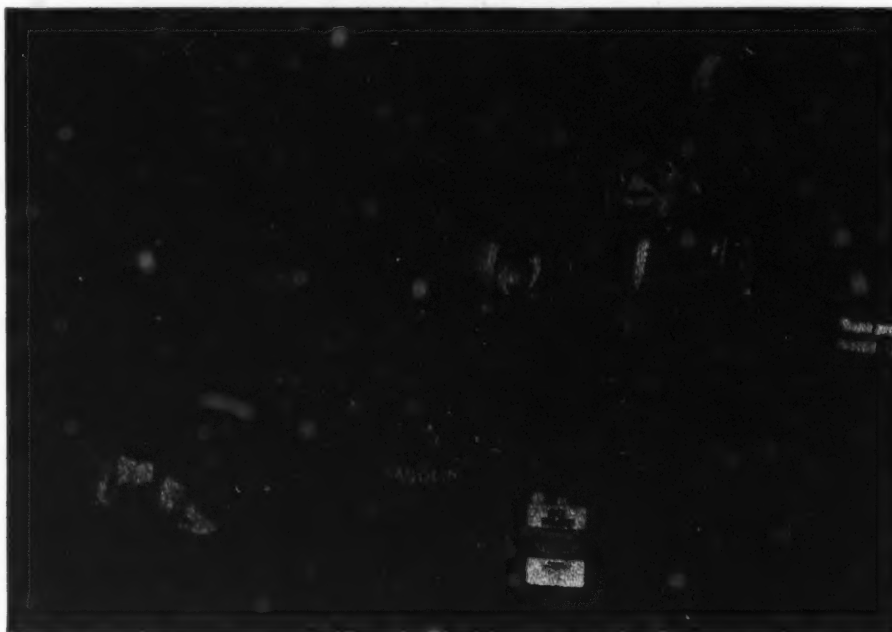
ASSIGNMENT SHEET #1 — IDENTIFY AUTO-BODY SHOP SAFETY VIOLATIONS

NAME _____

SCORE _____

A skilled auto-body technician is constantly aware of threats to his or her own safety and to the safety of others in the work area. The auto-body profession requires the use of many dangerous tools, and requires work in areas where an accident is possible with even momentary carelessness. In order to prevent serious injury or even death, safe auto-body technicians must always be on the lookout for dangerous situations in their work and in the work of those around them.

Study the following photograph and note any hazardous situations that exist. Write your list of dangerous conditions or practices on the lines below the photo.



SAFETY AND BASIC FIRST AID UNIT II

ASSIGNMENT SHEET #2 — MATCH FIRE-EXTINGUISHER SYMBOLS TO GIVEN TYPES OF CARPENTRY-RELATED FIRES

NAME _____

SCORE _____

One of the dangers of working in the auto-body trade is that the technician is exposed to potential fire hazards. In fact, at most auto-body shops, all four classes of fire are possible. Scrap lumber, rags, packaging, insulation, and other materials present the constant threat of a Class A fire. Class B fires can result from the wide use of gasoline and other flammable substances such as adhesives, paints and thinners, oils, and lubricants. Electrical wiring within the shop and the use of extension cords and electrical tools and equipment can create numerous Class C fire hazards. Even Class D metal fires are a possibility because of welding, cutting, and other operations that produce high temperatures. Thus, it is critical that auto-body technicians be able to determine quickly the source of a fire in order to select the correct fire extinguisher to fight it.

In this assignment, you are presented with descriptions of several fires and are asked to choose the correct extinguisher to use on each fire. List only the *minimum* type of acceptable fire extinguisher. For example, if a fire is a Class A fire, list only the A-type extinguisher, even though you could use an A, AB, or ABC extinguisher on that particular fire.

Match the following fire-extinguisher symbols to the given types of fires. Write the correct numbers in the blanks.

- ____ A. Fire in the old invoice filing cabinet
- ____ B. Smoke coming from the motor of an exhaust fan
- ____ C. Metal studs burning near a reinforcement weld
- ____ D. Fire caused by cigarette ashes dropping into adhesive spread over side trim molding
- ____ E. Fire in the carburetor of a gasoline-powered service vehicle
- ____ F. Smoke coming from a barrel of oily rags
- ____ G. Smoldering insulation around a shorted electrical outlet
- ____ H. Paper masking ignited by sparks from a grinder
- ____ I. Electric spray painter ignites
- ____ J. Can of paint thinner spills and the thinner bursts into flames when someone drops a lighted cigarette in it
- ____ K. Coffee pot hot plate is left unattended and ignites office paneling
- ____ L. Can of paint thinner explodes into flame, igniting wall containing exposed electrical outlets



SAFETY AND BASIC FIRST AID
UNIT IIASSIGNMENT SHEET #3 — ANALYZE CASE STUDIES TO DETERMINE
CORRECT FIRST-AID TREATMENTS

NAME _____

SCORE _____

Quick and effective use of first-aid procedures can save your life or the lives of your co-workers. Even in situations that are not life-threatening, first aid can reduce the seriousness of an injury or prevent it from becoming life-threatening. The first step in any emergency situation is to determine the nature and extent of the injuries so that you can determine the proper treatment.

Read the situations described below and decide what kind of treatment is required. State the suspected type of injury based on the description, and then outline the basic emergency first-aid steps you would take and the order in which you would take them. Be specific enough to show that you understand the problem and the basic treatment.

- A. A co-worker was uncrating some parts and stepped on a nail. The nail penetrated his shoe and entered his foot. The nail comes out easily, and there is minimal bleeding. However, a few minutes later, he complains of feeling queasy. You notice that he is pale and that his skin feels cold and clammy. After a moment, he says that he feels weak and wants to rest. What is the problem and how should it be treated?

Problem: _____

Treatment: _____

- B. One of the technicians was spray-painting near an open flame of a gas water heater. The spray ignited in a flash fire. The technician has burns over his face, hands, and forearms. He is experiencing intense pain when you arrive. His hands are swollen and covered with blisters. They appear to be wet, almost waxy. His eyebrows are burned away, and his face looks puffy. It is covered with scattered blisters and dark red patches. What kind of burn does he have, and how do you treat it?

Problem: _____

Treatment: _____

ASSIGNMENT SHEET #3

- C. An auto-body technician working near you has caught her hand in an alignment pull chain. Blood is gushing from the wound where the little finger has been severed and from a gash across her palm. When you wipe away the blood, streaks of white from tendons or bones show for a moment and then immediately disappear in the flow of blood. What actions should you take?

Treatment: _____

- D. One of your co-workers was plugging a battery charger into an extension cord in the wash bay when he screamed. There was a popping sound and a puff of smoke. The co-worker fell over and lay motionless on the floor. You turn off the electricity at the fuse box, and rush to the victim. On checking him, you find that his hand is swollen, mottled red, and smoke-scorched. Additionally, you notice that his lips and fingers are a bluish color. You check to see if he is breathing and find no sign of breath, though there is a weak pulse. What is the problem? What treatment is required?

Problem: _____

Treatment: _____

ASSIGNMENT SHEET #3

- E. While opening a can of metal preparation, an auto-body technician splatters the material into her eyes when the lid flies off suddenly. She grabs her eyes and begins screaming, "It burns! It burns!" What should you do?

Treatment: _____

- F. While working in the unair-conditioned shop on a hot August day, one of your co-workers begins to complain of being dizzy. You notice that he is sweating heavily and looks pale. Suddenly, he straightens out his left leg and begins rubbing the calf and thigh. He pulls up his pants leg, and you can see the muscles in his leg jerking spasmodically. What is the problem? What treatment should you provide?

Problem: _____

Treatment: _____

- G. One of the technicians on your job was thinning paint when there was a loud explosion. You look up to see her covered in flames. She begins running toward you, screaming. You knock her down and roll her on the ground to smother the flames. The thinner and paint continue to burn, but you have extinguished the flames on the victim's clothing. She is unconscious but breathing. Her pulse is rapid but weak. Her clothing is burned badly. Her legs are covered with ashy white burns surrounded by dark brown and black areas. Charred cloth from her pants is embedded in the burns. There is considerable blistering on her stomach, face, and hands. What is the problem? How should you care for this accident victim?

Problem: _____

Treatment: _____

ASSIGNMENT SHEET #3

- H. You and a friend are working on the friend's truck at his home, which is 30 miles from the nearest medical help. Your friend, who is carrying a battery, slips and falls. The battery flies out of his hands and lands on his lower leg. Upon questioning him and examining his leg, you discover that his lower leg is bent at an odd angle, and that there is discoloration, swelling, and considerable pain and tenderness at the injury site. What is the problem, and how would you treat it?

Problem: _____

Treatment: _____

SAFETY AND BASIC FIRST AID
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

- A. Technician wearing rings while working on vehicle
- B. Technician not wearing eye protection or face mask
- C. Vehicle is on jack but there is no safety stand
- D. Technician wearing loose-fitting clothing and long, unrolled sleeves
- E. Spill on the floor is not wiped up
- F. Dirty rags have been thrown around
- G. Flammable liquid container is not grounded
- H. Sparks from grinding around gas can, paint thinner, etc.
- I. Technician not wearing rubber gloves or apron while working on battery
- J. Electrical cord or air hose is strung out and left in work area

Assignment Sheet #2

- | | |
|------|------|
| A. 1 | G. 3 |
| B. 3 | H. 1 |
| C. 4 | I. 5 |
| D. 2 | J. 2 |
| E. 2 | K. 1 |
| F. 2 | L. 5 |

Assignment Sheet #3

- A. *Problem:* Traumatic shock
Treatment: Treat for shock
- B. *Problem:* Second-degree burn
Treatment:
 - 1. Prevent shock
 - 2. Examine victim carefully
 - 3. Treat for second-degree burns
 - 4. Seek medical help
 - 5. Keep checking and assisting until medical help is obtained
- C. *Treatment:*
 - 1. Control heavy bleeding by direct pressure
 - 2. Prevent shock
 - 3. Examine victim carefully
 - 4. After providing urgent care, transport victim *and* severed finger to hospital
 - 5. Continue checking and assisting until medical help is reached

ANSWERS TO ASSIGNMENT SHEETS

D. *Problem:* Respiratory failure and electrical burns caused by electrical shock*Treatment:*

1. Restore breathing
2. Prevent shock
3. Examine victim carefully
4. Treat electrical burn on hand just as you would treat a second-degree heat burn
5. Seek medical help
6. Keep checking and assisting until medical help is obtained

E. *Treatment:*

1. Do not let victim rub eyes
2. Immediately flood eyes with water from a tap, drinking fountain, or hose and continue flushing for fifteen minutes; then cover eyes with clean dressing
3. Prevent shock
4. Seek medical help
5. Keep checking and assisting until medical help is obtained

F. *Problem:* Heat cramps (probably a signal of oncoming heat exhaustion)*Treatment:*

1. Rescue co-worker by helping him to an air-conditioned room
2. Treat for heat cramps by applying firm pressure and warm, wet towels to cramped area, and by giving sips of salt water
3. Advise co-worker not to work in the hot shop for a few days

G. *Problem:* Loss of consciousness due to traumatic shock and second- and third-degree burns over a considerable portion of body*Treatment:*

1. Call for assistance, directing someone to extinguish the fire, and directing someone else to call for an ambulance
2. Treat to prevent shock
3. Treat blistered areas of stomach, face, and hands for second-degree burns; cover eyes with a clean, dry cloth
4. Treat burns on legs as for third-degree burns; do not remove the charred pieces of cloth from burns
5. Keep checking and assisting until medical help arrives

H. *Problem:* Suspected fracture*Treatment:*

1. Examine victim carefully
2. Treat to prevent shock
3. Prevent motion of injured leg and adjacent joints by splinting leg
4. Seek medical help (in this case, you will have to transport the victim to the hospital, taking care not to move the injured leg)

SAFETY AND BASIC FIRST AID
UNIT II

JOB SHEET #1 — PERFORM FIRST-AID TREATMENT
FOR SIMULATED ACCIDENT VICTIMS

I. Equipment and materials

A. Resuscitation doll

(NOTE: Never practice mouth-to-mouth resuscitation on a breathing person.)

B. Clean dressings (prepared gauze, clean handkerchiefs, clean articles of clothing)

C. Blankets

D. Water and basin

E. Rubbing alcohol

F. Salt

G. Cup or glass

H. Sterile dressings (gauze pads and cotton)

I. Splint material

J. Strips of material for securing splints

K. Towels

II. Procedure for victim of respiratory failure

A. Check for breathing

1. Look and listen
2. Check pulse on side of neck

B. Clear victim's air passage

1. Place victim flat on back (See Figure 3.)

(NOTE: If it is necessary to roll victim over, try to roll the victim over all at once, keeping back and neck straight to avoid making any possible spinal injury worse.)

JOB SHEET #1

FIGURE 3



2. Remove all foreign objects from victim's mouth and throat (Figure 4)

(NOTE: If there is an obstruction, carefully turn victim on side, tilt victim's head down, and clean mouth out with your fingers. When obstruction is removed, carefully position victim onto back again.)

FIGURE 4



JOB SHEET #1

3. Kneel at victim's side and lift up under the neck, tilting crown of head backwards (Figure 5)

(NOTE: If possible, place rolled piece of clothing under the victim's shoulders; this will help to secure the backward tilt of head.)

FIGURE 5



4. Pull the lower jaw so that the chin points straight up (Figure 6)

(NOTE: This will pull the tongue forward and open the air passage.)

FIGURE 6



JOB SHEET #1

C. Pinch the nostrils shut while still lifting up under victim's neck (Figure 7)

FIGURE 7



D. Inhale deeply, and while making an airtight seal with your mouth over the victim's mouth, breathe into victim's mouth until chest rises (Figure 8)

CAUTION

Keep victim's chin extended at all times.

FIGURE 8



JOB SHEET #1

- E. Remove your mouth from victim's mouth and listen for return flow of air (Figure 9)

FIGURE 9



- F. Continue breathing/listening procedure at rate of twelve breaths per minute for an adult, or one breath per five seconds for a child
- G. Repeat steps C through F until victim is breathing on his or her own or until medical help takes over treatment
- III. Procedure for bleeding victim

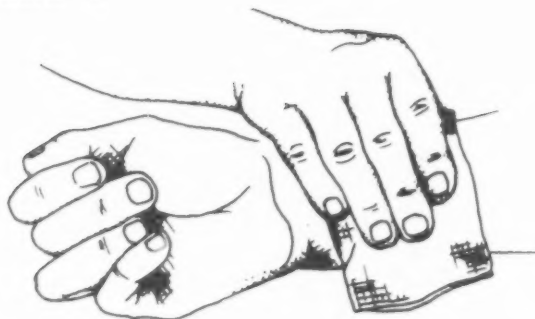
CAUTION

Never remove a penetrating object from a wound as this could be fatal for the victim. Apply dressing around the object as best you can. Direct pressure and elevation will stop bleeding from most wounds.

- A. Apply a thick dressing (prepared gauze, clean handkerchiefs, clean articles of clothing) directly over wound, and press *firmly* with hand (See Figure 10.)
- (NOTE: In some cases the bare hand has to be used until a suitable dressing can be found.)

JOB SHEET #1

FIGURE 10



- B. Elevate wound when you apply direct pressure if it does not cause pain and you do not suspect broken bones
- C. Check frequently to see if bleeding has stopped or slowed

CAUTION

Do not disturb blood clots after they have formed. If blood soaks through dressing, do not remove dressing, but add more layers.

- D. If bleeding is still active, apply a pressure bandage by holding the dressing in place with one hand, wrapping bandage directly over and around wound, and tying knot over wound (Figure 11)

FIGURE 11



JOB SHEET #1

- E. If bleeding continues, keep using direct pressure (and elevation when suitable), but also use a pressure point

(NOTE: Do not use a pressure point for an arm or leg wound unless direct pressure and elevation do not stop the bleeding.)

- F. When bleeding is under control, gradually release the pressure point

- G. Treat victim to prevent shock

(NOTE: A victim may suffer shock and loss of consciousness from loss of blood. Because it is possible to bleed to death in a very short period of time, bleeding should be given urgent care, and then the victim should be treated for shock.)

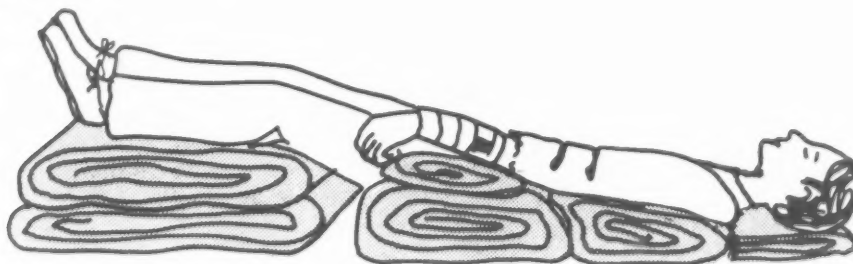
1. Keep victim lying down
2. If victim is bleeding from the mouth, place victim on one side so that blood will drain from mouth (Figure 12)

FIGURE 12



3. If victim feels faint, raise feet and legs—but only if moving the legs does not cause injury or pain (Figure 13)

FIGURE 13



JOB SHEET #1

4. If victim is having difficulty breathing, raise the head *and* shoulders to maintain adequate supply of oxygen (Figure 14)

CAUTION

Raising only the head may bend the neck and block the airway. Do not raise head and shoulders if you suspect a neck or back injury.

FIGURE 14



5. Cover victim to prevent loss of body heat and to stabilize blood circulation
6. Use good judgment in giving fluids

CAUTION

Give only a few sips of fluid at a time, and give no alcoholic beverages. If there is danger of choking, vomiting, or respiratory failure, give no fluids.

H. Get medical help as soon as possible

IV. Procedure for victim of heat distress

A. Heat stroke

(NOTE: Heat stroke is always a life-threatening situation. In heat stroke, the victim's temperature control system that causes sweating stops working correctly. The body temperature rises so high that brain damage and death will result if the victim is not cooled quickly.)

1. Move victim out of hot environment, preferably to an air-conditioned room
2. Cool the body immediately by soaking victim in cool but not cold water, sponging the body with rubbing alcohol or cool water, or pouring water on the body

JOB SHEET #1

3. When victim's body temperature has been reduced to a safe level (about 102° F), stop cooling process and observe the victim for about ten minutes
4. If temperature starts to rise again, cool the victim again
(NOTE: Use fans, air conditioners, or fan by hand to circulate air and promote cooling. Do not give coffee, tea, or alcoholic beverages.)
5. Transport to hospital immediately

B. Heat exhaustion

1. Move victim out of hot environment, preferably to an air-conditioned room
2. Loosen victim's clothing; apply cool, wet cloths; and fan to promote cooling
3. Give *sips* of salt water (two pinches of salt per glass of water) every fifteen minutes for an hour

CAUTION

If victim is vomiting, give no fluids. Transport to hospital. Medical care is needed for severe heat exhaustion.

4. Have victim remain lying down, and raise victim's feet 10 to 12 inches
5. Caution victim not to return to work for several days and to avoid further prolonged exposure to abnormally warm temperatures

C. Heat cramps

1. Move victim out of hot environment, preferably to an air-conditioned room
2. Apply firm pressure and warm, wet towels to cramped area
3. Give *sips* of salt water as for heat exhaustion

V. Procedure for burn victim

A. First-degree burns

1. Apply cold water or submerge burned area in cold water
2. Apply a dry, sterile dressing to protect injury if necessary

B. Second-degree burns

1. Submerge burned area in cold water until pain eases, or apply cold, wet cloths

(NOTE: Do not use ice water.)

JOB SHEET #1

2. Blot dry gently with sterile dressing or clean, lint-free cloths
3. Apply dry, sterile dressing, using care not to break blisters

CAUTION

Do not apply cream, ointments, sprays, or other substances to burn.

4. Treat to prevent shock

C. Third-degree burns

1. Cover burn with thick, sterile dressing

CAUTION

Do not apply water or immerse in water.

2. Immobilize burned area as much as possible; avoid removing tissue, clothing, or other materials contacting burned area
3. Treat to prevent shock
4. Transport victim to hospital as quickly as possible

VI. Procedure for victim of poisoning

A. Inhaled toxic gases, vapors, or mists

1. Remove victim to source of fresh air

(NOTE: If victim is in a closed room, garage, or other small space, take a deep breath and hold it before entering.)

2. While you attend to the victim, direct someone to call an emergency squad

(NOTE: The person who calls the emergency squad must indicate the nature of the problem and explain that oxygen should be brought to the scene.)

3. Loosen victim's tight clothing
4. If victim is unconscious, keep an open airway and give artificial respiration or CPR if indicated
5. Save label from or container of suspected poison for identification
6. Keep checking and assisting victim until medical help arrives

JOB SHEET #1

B. Absorption or skin contact with harsh or corrosive substance

1. Remove victim's contaminated clothing
2. Immediately drench and flush affected skin with large quantities of water
3. If poisoning is from corrosive substance, send for an ambulance immediately
4. Continue washing all contaminated skin with soap and water for at least five minutes
5. Keep victim's airway open and give artificial respiration if indicated
6. Keep checking and assisting victim until medical help arrives

C. Ingested poison

1. Dilute poison by having victim drink a glass of water or milk if victim is conscious and not having convulsions and if ingested substance is not corrosive

(NOTE: Discontinue dilution if it makes victim nauseated. If victim does vomit, save a sample of the vomit for identification of the poison.)

2. Seek medical assistance by calling poison control center or a physician

(NOTE: You should post the poison control center number for your region on your telephone. If you do not have the number, dial 0 or 911.)

3. If victim is unconscious, keep victim's airway open and give artificial respiration or CPR if indicated
4. Save label from container of suspected poison for identification
5. Keep checking and assisting victim until medical help arrives

VII. Procedure for victim with foreign object or substance in eye

(NOTE: In an urgent-care situation involving a victim with an object or substance in the eye, flush the eye immediately with water from a water fountain, gently running hose, or faucet. Never use a hose that is fitted with a power nozzle.)

- A. Wash hands
- B. Explain procedure to victim
- C. Position victim on affected side

(NOTE: This is done so that the contaminated fluid does not run from affected eye into good eye.)

JOB SHEET #1

- D. Moisten a sterile gauze pad with water and clean any debris from eyelid if there is no foreign object in eye

CAUTION

Always wipe from inner to outer side to prevent contamination. If you suspect a foreign object in the eye, do not press on eyelid as that may cause the object to embed.

- E. Use thumb and index finger to open eyelid
- F. Flush eye by gently directing a stream of room-temperature water into inner side of eye

CAUTION

Do not touch the edge of the water container to the eye.

- G. Flush eye for at least fifteen minutes, especially if condition is caused by a caustic substance
- H. Save flushed-out foreign object if this is what has caused the condition
- I. Place sterile gauze pad gently over eyelid and face
- J. Transport victim to hospital immediately
- VIII. Procedure for victim with suspected fracture

A. Closed fracture

1. Ask victim what happened and what victim thinks is wrong
2. Examine victim carefully

CAUTION

Do not move or have victim move body parts that may be injured.

(NOTE: After your initial examination, you will know whether an ambulance is needed. If such is the case, ask someone to call for an ambulance while you attend to the victim.)

3. If you cannot get immediate medical help, immobilize the joints above and below suspected fracture with splints, taking care to move the bones as little as possible

(NOTE: There are many types of splints available commercially; however, very satisfactory emergency splints can be made from corrugated cardboard, newspapers, boards, straight sticks, or rolled blankets.)

- a. Choose or create a splint long enough to extend past the joints on either side of suspected fracture

JOB SHEET #1

- b. Slide splints into place, taking care to move the bones as little as possible
- c. Place padding (folded cloths, dressings, handkerchiefs, etc.) between splint and skin, especially over bony places
- d. Hold splints in place with strips of cloth torn from clothing, with bandages, neckties, large handkerchiefs, or other suitable material

CAUTION

Do not cut off circulation by tying the cloth strips too tightly.

- e. In fractures of the arm or leg, inspect fingers and toes often for swelling or bluish discoloration—signs that the bandages are too tight
 - f. Loosen bandages and reapply them if these signs appear
- 4. Elevate limb slightly to reduce hemorrhage and swelling
 - 5. Treat to prevent shock
 - 6. Transport victim to hospital if an ambulance is not needed

B. Open fracture

(NOTE: Open fractures are much more serious than closed fractures because of tissue damage and bleeding, the danger of infection, and the fact that the fracture area is always contaminated.)

- 1. Remove or cut away victim's clothing in area of suspected fracture
- 2. Examine victim carefully

CAUTION

Do not move or have victim move body parts that may be injured.

(NOTE: After your initial examination, you will know whether an ambulance is needed. If such is the case, ask someone to call for an ambulance while you attend to the victim.)

- 3. If bone fragment is *not* protruding, control hemorrhage by applying pressure through a thick, sterile dressing over wound

CAUTION

Do not wash wound, probe wound, or insert your fingers in it.

JOB SHEET #1

4. If bone fragment is protruding, cover entire wound with large, thick, sterile bandage compress or pads; if these are not available, use freshly laundered sheets or towels

CAUTION

Never attempt to set or reduce a fracture or try to push a protruding bone end back in place.

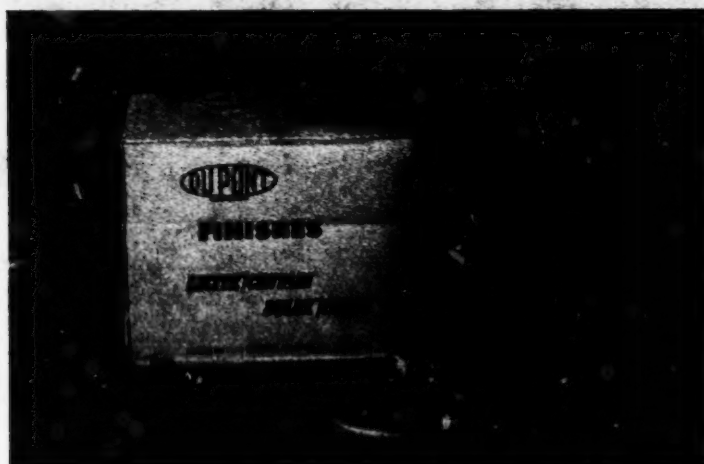
5. If you cannot get immediate medical help, apply splints as described for closed fractures
6. Elevate limb slightly to reduce hemorrhage and swelling
7. Treat to prevent shock
8. Transport victim to hospital if an ambulance is not needed

**SAFETY AND BASIC FIRST AID
UNIT II**

JOB SHEET #2 — PROPERLY LIFT A HEAVY OBJECT

- I. Equipment — Heavy object
- II. Procedure
 - A. Step up to object; place one foot beside object and one behind (Figure 15)

FIGURE 15



- B. Bend down and grasp object with whole hand (Figure 16)

FIGURE 16



- C. Tuck in chin (Figure 17)

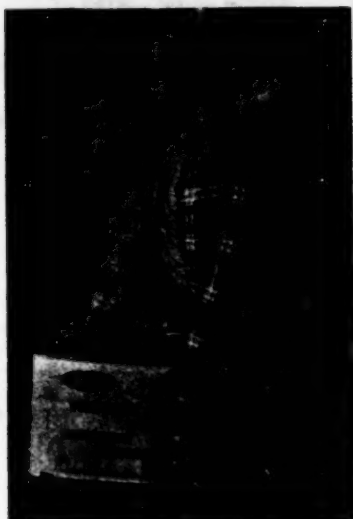
FIGURE 17



JOB SHEET #2

D. Tuck in elbows and arms
(Figure 18)

FIGURE 18



E. Hold load close to body (Figure 19)

FIGURE 19



F. Keep back straight and body weight directly over feet as you stand up (Figures 20 and 21)

FIGURE 20



FIGURE 21



SAFETY AND BASIC FIRST AID UNIT II

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with safety and basic first aid. Write the correct numbers in the blanks. Definitions are continued on the next page.

- | | |
|---|---------------------|
| _____a. Tending to blow up or burst violently and loudly | 1. Pressurized |
| _____b. Any suddenly occurring, unintentional event that causes injury or property damage | 2. Combustible |
| _____c. Act of reviving a person by bringing the person back to full consciousness | 3. Explosive |
| _____d. To put out a fire; to quench or smother | 4. Carelessness |
| _____e. Freedom from danger, risk, or injury | 5. First aid |
| _____f. Source of danger | 6. Safety |
| _____g. Stored under pressure greater than the pressure of the atmosphere | 7. Accident |
| _____h. Any device, such as a bandage and stick, used to compress a blood vessel to stop bleeding or to control blood flow | 8. Extinguish |
| _____i. Negligence; failure to think before one acts, or failure to pay attention | 9. Resuscitation |
| _____j. Capable of bursting into flames | 10. Tourniquet |
| _____k. Heavy loss of blood | 11. Traumatic shock |
| _____l. Capable of being easily ignited and burning with extreme rapidity | 12. Hemorrhage |
| _____m. Immediate, temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained | 13. Open fracture |
| _____n. Depressed condition of many of the body functions due to failure of enough blood to circulate through the body following serious injury | 14. Hazard |
| | 15. Flammable |
| | 16. Closed fracture |

TEST

- _____o. Broken bone associated with an open wound
- _____p. Broken bone beneath the skin with no open wound

2. State job safety rules for the following categories.

General (State three rules.)

- a. _____

- b. _____

- c. _____

Dress (State three rules.)

- a. _____

- b. _____

- c. _____

Equipment and tools (State six rules.)

- a. _____

- b. _____

- c. _____

TEST

- d. _____

e. _____

f. _____

Work area (State six rules.)

- a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

Flammable liquids and toxic substances (State five rules.)

- a. _____

b. _____

c. _____

TEST

d. _____

e. _____

Vehicles (State four rules.)

a. _____

b. _____

c. _____

d. _____

3. Match colors of the safety color code to their correct applications. Write the correct numbers in the blanks. Answers may be used more than once. Applications are continued on the next page.

- | | |
|---|---|
| _____ a. Designates radiation hazards | 1. Federal safety red |
| _____ b. Designates safety starter buttons and parts of equipment that may cause electrical shock | 2. Federal safety yellow |
| _____ c. Designates items for housekeeping purposes | 3. Federal safety orange |
| _____ d. Designates location of first-aid equipment | 4. Federal safety purple (or black or magenta on safety yellow) |
| _____ e. Identifies fire-protection equipment and its location | 5. Federal safety blue |
| _____ f. Designates waste containers for explosive or combustible materials | 6. Federal safety green |
| _____ g. Designates caution against and provides information about machines or equipment out of order or under repair | 7. Federal safety black and white (used individually or in combination) |
| _____ h. Designates danger | |

TEST

- ____i. Designates exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws
 - ____j. Designates caution against starting, using, or moving equipment while it is under repair; and against the use of defective equipment
 - ____k. Designates storage areas
 - ____l. Designates dangerous parts of equipment that may cut, crush, shock, or otherwise injure
 - ____m. Identifies portable containers of flammable liquids
 - ____n. Designates location of safety equipment other than fire-fighting equipment
 - ____o. Identifies emergency stop bars, stop buttons, and emergency electrical stop switches on machinery
 - ____p. Identifies out-of-order signs on equipment
 - ____q. Identifies the starting point or power source of machinery
 - ____r. Designates traffic flow
 - ____s. Designates caution and marks physical hazards
4. Match classes of fires to their correct descriptions. Write the correct numbers in the blanks.
- | | |
|--|------------|
| ____a. Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners | 1. Class A |
| ____b. Fires that occur in ordinary combustible materials, such as wood, rags, rubber, and plastics | 2. Class B |
| ____c. Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring | 3. Class C |
| ____d. Fires that occur with combustible metals, such as iron, magnesium, sodium, and potassium | 4. Class D |

TEST

5. Discuss why knowledge of first aid is important.

6. Arrange in order first-aid actions to follow in an emergency. Write a "1" in the blank before the first step, a "2" in the blank before the second step, and so on.

- ____ a. Control heavy bleeding
- ____ b. Restore or maintain breathing and heartbeat
- ____ c. Rescue victim and yourself
- ____ d. Examine victim carefully
- ____ e. Treat for poisoning
- ____ f. Prevent shock
- ____ g. Keep checking and assisting victim until medical help is obtained
- ____ h. Seek medical help

7. List carpentry-related injuries that require the administration of first aid.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

TEST

- f. _____
- g. _____
- h. _____
- i. _____

8. Discuss symptoms of traumatic shock.

Early stages

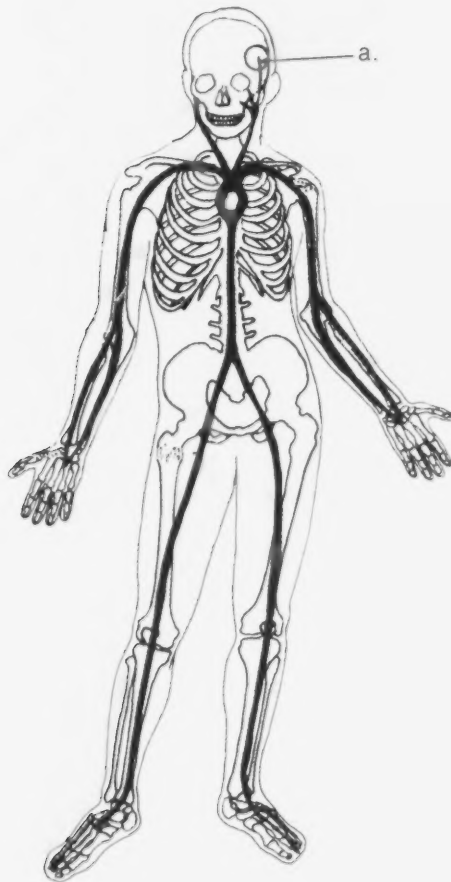
Late stages

9. State four measures to take for prevention of heat stroke, heat cramps, and heat exhaustion.

- a. _____
- b. _____
- c. _____
- d. _____

TEST

10. Distinguish between symptoms of heat stroke and heat exhaustion. Write an "X" in the blank before symptoms of heat stroke.
- ____a. Flushed, hot, dry skin and high body temperature
- ____b. Pale, cool, clammy skin and normal body temperature
11. Identify pressure points to use to control bleeding from various areas of the body. Circle the pressure points on the illustration below, and label each with the letter that corresponds to the area of bleeding it controls. (Pressure point "a" is shown as an example.)
- | | |
|-------------------------------------|--|
| a. Bleeding from scalp | f. Bleeding from upper arm or shoulder |
| b. Bleeding from face | g. Bleeding from neck |
| c. Bleeding from thigh | h. Bleeding from foot |
| d. Bleeding from lower leg | i. Bleeding from lower arm or hand |
| e. Bleeding from lower arm or elbow | |



TEST

12. Classify burns by degree according to their symptoms. Write a "1" in the blanks before symptoms of first-degree burns, a "2" before symptoms of second-degree burns, and a "3" in the blanks before symptoms of third-degree burns.

- _____a. Damage extending into first layer of tissue
- _____b. Less pain because of nerve destruction
- _____c. Rapid healing
- _____d. Blistering
- _____e. Charred or white appearance of burned area
- _____f. Mild swelling and pain
- _____g. Considerable swelling
- _____h. Pain greater than that caused by first-degree burn
- _____i. Deep tissue destruction
- _____j. Wet appearance of burned area due to loss of plasma
- _____k. Redness or discoloration
- _____l. Mottled or red areas

13. List guidelines for administering first aid to a victim with an eye injury.

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

TEST

14. Discuss signs and symptoms of fractures.

15. List six guidelines for administering first aid to a victim with a suspected fracture.

- a.

- b.

- c.

- d.

- e.

- f.

(NOTE: Test question 16 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

16. Demonstrate the ability to

- a. Perform first-aid treatment for simulated accident victims.
- b. Properly lift a heavy object.

SAFETY AND BASIC FIRST AID UNIT II

ANSWERS TO TEST

- | | | |
|---------|-------|-------|
| 1. a. 3 | g. 1 | m. 5 |
| b. 7 | h. 10 | n. 11 |
| c. 9 | i. 4 | o. 13 |
| d. 8 | j. 2 | p. 16 |
| e. 6 | k. 12 | |
| f. 14 | l. 15 | |

2. **General** — Answer should include any three of the following

- a. Be familiar with location of fire-fighting and first-aid equipment
- b. Be alert and conduct yourself in a manner that will ensure safe practices
- c. Be conscious of others' safety
- d. Report all accidents to the supervisor, regardless of nature or severity

Dress — Answer should include any three of the following

- a. Wear close-fitting clothing appropriate for activity being performed
- b. Wear safety glasses in the shop area at all times
- c. Confine long hair before operating power equipment
- d. Wear goggles, apron, safety shoes, gloves, ear protection, and respiratory equipment when required
- e. Remove rings and other jewelry when working
- f. Do not carry sharp tools in pockets

Equipment and tools — Answer should include any six of the following

- a. Obey all safety rules, and observe limitations on equipment according to specifications and manufacturer's requirements
- b. Keep all tools sharp and clean, in safe working order, and properly stored when not in use
- c. Retain guards and safety devices on all equipment
- d. Tag and report to the supervisor any defective tools, machines, or other equipment
- e. Be sure to shut off all power equipment when finished with it, and do not leave equipment until it has stopped completely
- f. Operate equipment *only after* receiving instructions on how to operate it safely
- g. Disconnect power from equipment before changing accessories and before performing service or maintenance on it
- h. Use the correct tool for the job
- i. Clean debris from sanders, grinders, and other equipment with a brush, not with your hands or a rag; *do not* clean equipment while it is running
- j. Position proper supporting devices under heavy objects and elevated vehicles
- k. Follow safety rules furnished with and concerning pneumatic (air-powered) equipment
- l. Never use compressed air to clean yourself or your clothing

ANSWERS TO TEST

Work area — Answer should include any six of the following

- a. Arrange equipment to permit safety-efficient work practices and ease of cleaning
- b. Store materials and supplies safely in their proper places
- c. Store tools and accessories safely in cabinets, on racks, or in suitable storage areas
- d. Keep work area clear of debris and other hazards
- e. Clean floors of obstructions and slippery substances; clean up spills immediately
- f. Keep aisles, exits, and traffic areas free of materials and debris
- g. Dispose of combustible materials properly
- h. Keep sufficient brooms, brushes, waste containers, and other housekeeping equipment readily available

Flammable liquids and toxic substances — Answer should include any five of the following

- a. Carefully read labels on all flammable liquids, and use only in open, well-ventilated areas
- b. Be cautious of inhaling or igniting fumes from flammable liquids and toxic substances
- c. Be sure that all flammable liquids are marked correctly for storage
- d. Store all flammable liquids properly in approved safety containers
- e. Immediately change clothing soaked by flammable liquids
- f. Use flammable liquids only for their intended purposes
- g. Do not use flammable liquids near fire or flame
- h. Always know location of appropriate fire extinguisher
- i. Stop, drop, and roll, if your hair or clothing catches fire; *never* run

Vehicles — Answer should include any four of the following

- a. Use caution to prevent contact with hot manifolds and hoses
- b. Be sure that vehicle engine is out of gear before starting
- c. Always keep appropriate fire extinguisher near when starting and operating vehicle
- d. Do not pour gasoline into carburetor or cylinder head when starting engine
- e. Never pour gasoline into fuel tank when engine is hot or when engine is running
- f. Do not operate vehicle that is leaking gasoline

- | | | | | |
|----|------|------|------|------|
| 3. | a. 4 | f. 2 | k. 7 | p. 5 |
| | b. 3 | g. 5 | l. 3 | q. 2 |
| | c. 7 | h. 1 | m. 1 | r. 7 |
| | d. 6 | i. 3 | n. 6 | s. 2 |
| | e. 1 | j. 2 | o. 1 | |

- 4.
- a. 2
- b. 1
- c. 3
- d. 4

ANSWERS TO TEST

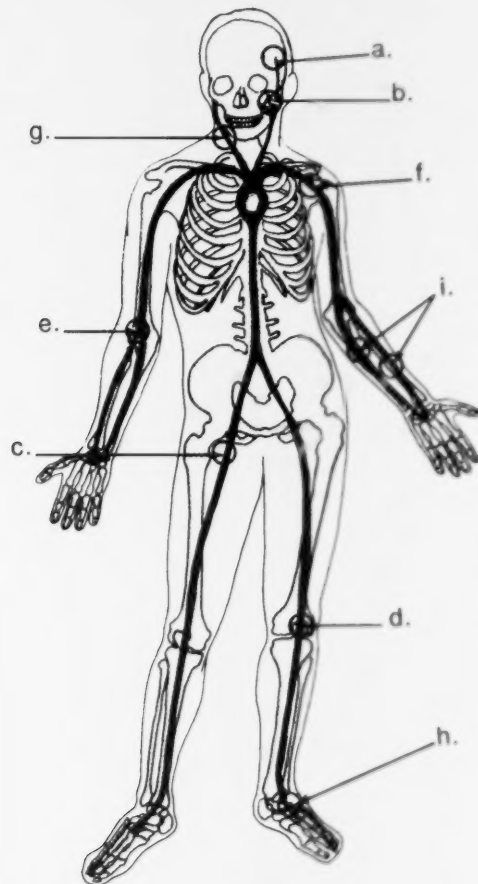
5. Discussion should include the following
- a. May mean the difference between life and death
 - b. May mean the difference between temporary and permanent disability
 - c. May mean the difference between rapid recovery and long hospitalization
 - d. Prepares one for what to do and what not to do in an emergency
 - e. Promotes safety awareness
- 6.
- | | |
|------|------|
| a. 3 | e. 4 |
| b. 2 | f. 5 |
| c. 1 | g. 8 |
| d. 6 | h. 7 |
- 7.
- a. Bleeding
 - b. Chemical burns
 - c. Electrical burns
 - d. Poisoning
 - e. Loss of consciousness
 - f. Respiratory failure/cardiac arrest
 - g. Eye injuries
 - h. Muscle and ligament strain or sprain
 - i. Broken bones
8. Discussion should include the following
- Early stages**
- a. Pale or bluish skin that is cold to the touch
 - b. Moist, clammy skin if perspiration has occurred
 - c. Weakness
 - d. Rapid pulse (over 100 beats/minute), often too faint to be felt in wrist but perceptible in carotid artery at the side of neck or femoral artery at groin
 - e. Increased rate of breathing that may be shallow or possibly deep and irregular
 - f. Restlessness, anxiousness, severe thirst if victim is in shock from hemorrhage
 - g. Vomiting or nausea
- Late stages**
- a. Apathy and relative lack of responsiveness
 - b. Sunken eyes with vacant expression and widely dilated pupils
 - c. Mottled appearance to skin, indicating that victim's blood pressure has fallen to a very low level
 - d. Loss of consciousness, low body temperature, and death if untreated

ANSWERS TO TEST

9. Answer should include any four of the following
- Drink plenty of fluids
 - Increase salt intake
 - Do not overexert
 - Wear lightweight clothing that allows sweat to evaporate
 - Keep head covered and face shaded
 - Take frequent short work breaks
 - Rest in the shade or an air-conditioned room whenever possible

10. a

11.



- | | | | | |
|-----|------|------|------|------|
| 12. | a. 2 | d. 2 | g. 2 | j. 2 |
| | b. 3 | e. 3 | h. 2 | k. 1 |
| | c. 1 | f. 1 | i. 3 | l. 2 |

ANSWERS TO TEST

13.
 - a. Do not let victim rub the eye
 - b. Do not attempt to remove a foreign object by using any sharp object
 - c. Keep victim flat on back if injury is caused by a penetrating object or a severe blow
 - d. Cover eye with a clean dressing if foreign object is lodged in eye and cannot be removed easily by flushing with water or by using a clean cloth
 - e. Immediately flood chemical substances in eye with water

14. Discussion should include the following
 - a. Victim's account of accident
 - b. Differences in shape and length of corresponding bones on the two sides of body
 - c. Obvious deformities
 - d. Swelling
 - e. Discoloration
 - f. Pain or tenderness to touch

15. Answer should include any six of the following
 - a. Prevent motion of the injured parts and adjacent joints
 - b. When an injured person obviously requires hospitalization and an ambulance is on the way, do not attempt to move the victim unless there is a life-threatening emergency
 - c. Give priority to open fractures over closed fractures unless associated injuries dictate otherwise
 - d. Never test for fracture by having the victim move the part or try to walk on a possibly broken leg
 - e. Never attempt to set or reduce a fracture or try to push a protruding bone end back in place
 - f. If possible, take time to tie a victim's injured leg to the uninjured one, or to bind the injured arm to the chest or side
 - g. Do not allow victim to move the head (or do not move it yourself) when there is a possible neck or spine fracture
 - h. Lift and move an unconscious victim as though the injury is to the neck or spine—provide rigid support for victim's back and head
 - i. After providing urgent care, treat to prevent shock

16. Performance skills evaluated to the satisfaction of the instructor

PAINT AND BODY SHOP SAFETY
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able use correct safety methods when working with paint and body shop specialty tools and materials. The student will show this knowledge by completing the unit test with a minimum score of 100 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. State general safety rules for paint and body shop.
2. Match personal safety equipment to their correct uses.
3. State safety rules for the prevention of fire and explosion.
4. State safety rules pertaining to batteries.
5. Select from a list guidelines for safe use of respirators.
6. Select from a list handling precautions for urethanes and urethane additives (isocyanates).
7. State first-aid measures to take for urethane and urethane additive accidents.
8. State safety rules for paint room waste disposal.
9. Select from a list rules for safe use of disc sanders, grinders, and polishers.

PAINT AND BODY SHOP SAFETY
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Supplements
 - 1. Supplement #1 — Inspect a Respirator
 - 2. Supplement #2 — Fit a Respirator Having a Hook-and-Eye Headband
 - 3. Supplement #3 — Complete a Respirator-Fitting Test Evaluation
- D. Information sheet
- E. Assignment Sheet #1 — Complete Paint and Body Shop Safety Rules
- F. Answers to assignment sheet
- G. Test
- H. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Obtain materials to supplement the unit.
 - 1. *Auto Body Safety*, 1 cassette, 1 filmstrip; available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628

(NOTE: This filmstrip covers safety techniques for the use of power tools, heating equipment, painting and air-compressing equipment. It also identifies hazardous areas and describes and illustrates safe use of volatile substances such as plastic fillers, primers, acrylic enamel, acrylic lacquer, and thinners.)

- 2. Brochures, pamphlets or other information related to auto-body shop safety

(NOTE: Contact local jobbers and suppliers.)

- 3. Battery charger and uncharged battery

SUGGESTED ACTIVITIES

4. Jumper cables
5. Case studies and newspaper clippings about automotive paint and body shop explosions and fires
6. Respirators, filters, prefilters, cartridges, and instruction manuals

(NOTE: If students are to complete Supplement #2, you will need to obtain a respirator with a hook-and-eye headband.)

7. Germicidal solution for demonstrating how to clean and disinfect a respirator
8. Labels from urethanes and urethane additives
9. Competency profiles

(NOTE: Competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

- C. Provide students with unit.
- D. Introduce unit by stressing the importance of observing correct shop safety precautions.

SUGGESTIONS:

- Stress that at times the working environment within a paint and body shop is hazardous and that the worker must adhere to correct precautionary measures.
 - List various areas of the shop and pieces of equipment that are potential health hazards.
 - Tour the shop, pointing out potential safety and health hazards.
 - Show filmstrip *Auto Body Safety*.
- E. Discuss unit and specific objectives, pointing out that the material in this unit is important enough to require a score of 100 percent on the unit test.
 - F. Discuss information sheet.
 1. Use Information Sheet, Section I to discuss general safety rules for paint and body shop.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Explain that paint and body shop workers must be alert to potential hazards and must observe all basic safety rules in order to protect themselves and others from accidents. Basic safety rules must be taken seriously because the consequences of not obeying the rules are serious. There is no room for horseplay, especially in a school shop with a large number of students.
- Point out or demonstrate any special safety precautions or techniques particular to your equipment or shop.

EXAMPLES: Emergency exit procedure, fire drill procedure, emergency storm procedure

2. Use Information Sheet, Section II to discuss personal safety equipment and its uses.

SUGGESTIONS:

- Have personal protective equipment available for demonstration.

EXAMPLES: Respirator, gloves, safety goggles, protective clothing

- Point out that personal protective equipment (gloves, respirators, goggles, protective clothing, etc.) functions as a physical barrier.
 - Explain that specific safety and health regulations regarding personal protective equipment are covered by the Occupational Safety and Health Act (OSHA).
 - Stress that skin and eye protection must be selected on the basis of the nature of the hazard presented by the product. *The worker must read the manufacturer's label.*
 - Have students read labels from various products used in the paint and body shop, and then have them list on the chalkboard or individually the protective clothing that must be worn when using each product.
3. Use Information Sheet, Section III to discuss safety rules for the prevention of fire and explosion.

SUGGESTIONS:

- Explain that most painting materials contain volatile solvents that are highly flammable. Point out that extreme care must be exercised and the work area must be clean and correctly maintained.

SUGGESTED ACTIVITIES

- Explain that paint and solvent products should be kept away from all sources of ignition including heat, sparks, flame, motors, burners, heaters, and pilot lights.
 - Display on a bulletin board case studies or newspaper clippings of fires or explosions related to automotive paint and body shops.
 - Explain and demonstrate any fire prevention rules or procedures particular to your shop.
4. Use Information Sheet, Section IV to discuss safety rules pertaining to batteries.

SUGGESTIONS:

- Explain that batteries are so common that they are often overlooked as a potential hazard. Explain that a battery can explode like a bomb and can cause permanent skin and eye damage.
 - Demonstrate the correct way to charge a battery (see Unit XI). Stress the correct method of connecting and disconnecting charger cables.
 - Demonstrate the correct procedure for using jumper cables.
5. Use Information Sheet, Section V to introduce students to guidelines for safe use of respirators.

SUGGESTIONS:

- Stress that the breathed vapor of any chemical may affect a person's health.
- Explain that the respirator should not be used for protection against vapors, gases, or contaminants that may penetrate the skin or irritate or injure the eyes. Caution students against obtaining a false sense of security just because they are wearing respirators.
- Explain that the need for filter replacement varies with the concentration of dust, mist, or fumes and with the amount of activity of the respirator wearer.
- Point out that prefilters and cartridges should be replaced periodically for continued effective protection. When it becomes difficult to breathe through the respirator, it is time to replace the prefilters. When the wearer detects any solvent odor or irritation, it is time to replace the cartridges. It is impossible to predict the maximum useful life of cartridges and prefilters because their useful life depends on conditions of use, but it is good practice to replace both the cartridges and prefilters at least once a week.

SUGGESTED ACTIVITIES

- Demonstrate cartridge and prefilter replacement, following manufacturer's recommended procedures.
 - Use Supplements #1 through #3 to demonstrate inspection, fitting, and testing of a respirator.
 - Demonstrate the washing and disinfecting procedure for care of respirators. Explain that respirators should be washed in a germicidal solution and that new air-purifying elements should be replaced.
 - Demonstrate how to inspect a respirator. Point out the valves and valve seats. Stress that the valves and valve seats must be clean and free of cracks, nicks, and tears.
6. Use Information Sheet, Section VI to discuss handling precautions for urethanes and urethane additives (isocyanates).

SUGGESTIONS:

- Reinforce the importance of reading manufacturers' warning labels by having students list the warnings from several labels.
 - Explain that isocyanates are very hazardous and that correct handling procedures must be used today for tomorrow's health.
 - Explain that only respirators approved by the National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) should be used and that choosing the right cartridge and prefilter is all-important. Using the wrong cartridge and prefilter may be like using no respirator at all.
7. Use Information Sheet, Section VII to discuss first-aid measures to take for urethane and urethane additive accidents.

SUGGESTIONS:

- Stress the importance of reading and observing warnings on warning labels and of using appropriate personal safety equipment.
- Stress the importance of taking immediate action in the event of skin, eye, or lung exposure to these chemicals.
- Explain that in the event of an accident, the manufacturer's label instructions will be required by the attending physician.
- Demonstrate your shop first-aid procedures for urethane accidents. Show students how to use flushing equipment if it is available.

SUGGESTED ACTIVITIES

8. Use Information Sheet, Section VIII to discuss safety rules for paint room waste disposal.

SUGGESTIONS:

- Prepare a disposal guide sheet for your shop and post it on the bulletin board.
 - Explain your disposal requirements and methods so that students will know what procedure is expected.
9. Use Information Sheet, Section IX to discuss rules for safe use of disc sanders, grinders, and polishers.

SUGGESTIONS:

- Explain that a sharp tool such as a knife will cut or slice and that a physician can stitch such a wound together. Then explain that a grinder removes skin and bone, making medical repair very difficult.
- Stress that only the accessories designed for a piece of equipment should be used on that piece of equipment. Explain the difference between the rim speeds of 7-inch and 9-inch abrasive discs on a 5500 rpm grinder.
- Explain the difference in heat buildup of the two disc sizes, and discuss how using the wrong disc may cause warpage because of the difference in heat buildup. Point out that the adhesive used to bond the abrasive together is designed for a specific speed and that if this speed is exceeded, separation will occur.
- Explain what happens when an operating sander or grinder gets caught in loose clothing. Use case studies to illustrate your explanation. Stress the importance of wearing eye protection.

G. Give test.

H. Critique test and discuss in class.

I. Retest if necessary.

J. Complete appropriate section of competency profiles.

III. Unit references

- A. Toboldt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Company, Incorporated, 1972.
- B. U.S. Department of Labor. *Federal Register*, Vol. 36, Number 105, Part II. May 29, 1971.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — INSPECT A RESPIRATOR

Respirators are designed to provide protection from vapors, mists, and airborne particles that may cause potential health problems. To offer maximum or effective protection, a respirator must be in good condition, must be worn correctly, and must fit properly.

Using the information in Part I of this supplement as a guide, inspect the physical condition of an air-purifying, dual-element, cartridge-type respirator. Report your results in Part II.

PART I — Inspection Procedure

- A. Check to ensure that rubber exhalation flap is secured firmly to plastic exhalation valve seat
- B. Check to ensure that air-purifying elements are firmly attached
- C. Check for correct alignment of plastic adapters (receptacles for air-purifying elements) on the rubber facepiece
 - 1. Look inside facepiece
 - 2. Check to see that the letters "A" and "B" on round inhalation valve seat are aligned with the "A" and "B" on facepiece side walls
 - 3. Correct misalignment by twisting improperly positioned adapter until letters align

PART II — Evaluation Results

Respirator approved for use _____

Date _____

Respirator disapproved for use _____

Explain reason(s) _____

SUGGESTED ACTIVITIES

SUPPLEMENT #2 — FIT A RESPIRATOR HAVING A HOOK-AND-EYE HEADBAND

A respirator must fit properly if it is to provide the intended protection for the technician. In addition to providing protection, a respirator should feel comfortable. To obtain these two objectives, the wearer must properly fit the respirator to his or her physical needs.

Using the following procedure, put on a respirator and adjust the hook-and-eye headband.

(NOTE: The respirator is worn so that the narrow, upper portion of the rubber facepiece covers the nose and the wide, lower portion is under the chin. See Figure 1 below.)

FIGURE 1



- A. Fasten bottom headband around neck below ears

(NOTE: The respirator should hang with the narrow end down and with the inside surface of the facepiece facing out.)

- B. Position respirator on face so that wide portion of facepiece is under chin and narrow portion is over nose
- C. Fasten top headband around head above ears

SUPPLEMENT #2

D. Adjust tension in headband straps

(NOTE: Respirator headstraps should be as comfortable as possible and still provide satisfactory facepiece-to-face seal. Tightening the straps may sometimes improve facepiece fit.)

1. Hold hook or eye with thumb and forefinger of one hand
2. Grasp loose end of strap with other hand
3. Pull straight up to release strap from open end of hook or eye
4. Pull strap forward to tighten or backward to loosen
5. Reset loose end of strap in open end of hook or eye to prevent end from slipping

SUGGESTED ACTIVITIES

SUPPLEMENT #3 — COMPLETE A RESPIRATOR-FITTING TEST EVALUATION

To be effective, not only must a respirator be in good physical condition but it must fit the wearer to prevent leakage. Before entering a hazardous atmosphere, the wearer should perform a positive and negative pressure test to maintain adequate protection against contamination.

Using the procedures in Part I of this supplement as a guide, perform a respirator-fitting test. Record your test results in Part II.

PART I — Procedures

A. Positive pressure test

1. Put on respirator
2. Close off exhalation valve by placing palm of one hand over valve
(NOTE: Take care not to disturb the position of the facepiece.)
3. Exhale gently into facepiece
4. Observe fit

(NOTE: Face fit is satisfactory if a slight pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal.)

B. Negative pressure test

1. Put on respirator
2. Close off filter cartridge inlet openings by covering with palms of hands
(NOTE: Inlets may be sealed with tape for this test.)
3. Inhale so that facepiece collapses slightly and hold breath for ten seconds
4. Observe fit

(NOTE: If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is satisfactory.)

PART II — Evaluation Results

	Yes	No
A. Positive pressure test satisfactory	☐	☐
B. Negative pressure test satisfactory	☐	☐

PAINT AND BODY SHOP SAFETY
UNIT III

INFORMATION SHEET

I. General safety rules for paint and body shop

- A. Ensure proper ventilation and adequate air circulation in all spray-painting areas
- B. Make sure that paint booths are equipped with explosionproof lights, automatic sprinklers or fire extinguishers, and "No-Smoking" signs
- C. Store creepers standing up when not in use
- D. Use only nonsparking electric motors in spray-painting areas
- E. Use pressure of no more than 30 pounds per square inch (psi) for air hoses used to blow dirt off parts
- F. Separate spray finishing operations from other work areas
- G. When spray painting, wear respirator approved for material being sprayed
- H. Do not use electrical equipment in any spraying area subject to deposits of combustible residue
- I. Keep spraying areas free of accumulated deposits of combustible residue
- J. Never try to stop a leak in an air hose or hydraulic hose with your hand
- K. Perform cleaning, lubricating, and adjustment of equipment only after disconnecting equipment from power source
- L. Report defective tools or equipment to your instructor or supervisor

II. Uses of personal safety devices

- A. Safety shoes — Worn for protection when there is danger of injury from falling or dropped objects
- B. Gloves — Worn for protection when working with cleaners, acids, reducers, grinders and sharp edges, and when welding
- C. Ear plugs or earmuffs — Worn for protection when noise level exceeds 90 decibels
- D. Safety glasses or goggles — Worn for protection when cleaning parts, working beneath vehicles, handling chemicals, grinding, polishing, sanding, or welding

(NOTE: Safety glasses or goggles should be worn at all times in the shop area.)

INFORMATION SHEET

- E. Respirator — Worn for protection when working in any area contaminated with harmful dust, fogs, fumes, mists, gases, paints, or sprays
 - F. Dust mask — Worn for protection when sanding painted surfaces or sanding body filler
 - G. Close-fitting clothing — Worn for protection when using rotating machinery or flammable substances
- III. Safety rules for the prevention of fire and explosion
- A. Do not weld near gas tanks, fuel lines, lacquer thinner, enamel reducer, paint, or any combustible materials
 - B. Do not overload electrical circuits
 - C. Do not use frayed or defective electrical cords
 - D. Do not make any electrical repairs unless supervised by the instructor
 - E. Do not run over extension cords or drop-light cords with vehicles, jacks, or creepers
 - F. Keep all solvent containers closed except when pouring
 - G. Handle all solvents with care to avoid spillage
 - H. Do not smoke, light matches, or use a torch in the paint area
 - I. Always *push* painted vehicle from paint booth
- (NOTE: The spark from the ignition of the motor could cause an explosion.)
- J. Make sure that your hands and clothing are free of solvents or thinners before lighting matches or smoking
 - K. Hook a ground wire from one container to another when transferring flammable liquids
- (NOTE: All containers of flammable liquids should be properly grounded at all times.)
- L. Never puncture or attempt to weld an empty thinner or reducer drum
- IV. Safety rules pertaining to batteries
- A. Disconnect batteries when working on or near electrical systems and before charging operations

INFORMATION SHEET

- B. Turn off battery charger before connecting or disconnecting charger cables
- C. Keep all fire away from batteries being charged
- D. Never test the condition of a battery by shorting across the terminals
- E. Do not leave battery charger on "fast charge" for very long at one time
- F. Do not charge battery in a small room for very long without sufficient ventilation
- G. Always observe correct polarity when servicing batteries

(NOTE: Disconnect ground terminal *first* and reconnect *last* when servicing batteries.)

- H. Handle battery acid carefully and keep it away from skin and clothing

V. Guidelines for safe use of respirators

(NOTE: High concentrations of air contaminants and insufficient oxygen to sustain life may be present in closed or poorly ventilated spaces. Respirators will not provide sufficient protection from these conditions.)

- A. Use respirators for respiratory protection only in atmospheres containing dust, fumes, vapors, or sprays that *do not* pose an immediate threat to life or health
- B. Use respirator equipped with air-purifying elements designed for protection against vapors and gases when working with vapors and gases
- C. Use respirator equipped with air-purifying elements designed for protection against airborne particles when working with airborne particles

VI. Handling precautions for urethanes and urethane additives (isocyanates)

- A. Read and observe product manufacturer's instructions and warnings
- B. Know that urethanes containing isocyanates are hazardous materials that may cause lung irritation and allergic respiratory reactions
- C. Do not use isocyanates if you have chronic (long-term) lung or breathing problems
- D. Use isocyanates only in a well-ventilated area
- E. Wear a respirator while spraying and until all vapors and mists are gone

(NOTE: If overspray is present, it is recommended that you wear a pressure-demand or continuous-flow, atmosphere-supplying respirator approved by NIOSH or MSHA.)

INFORMATION SHEET

- F. Wear a respirator containing only filters approved for isocyanate vapors or mists
 - G. Follow all respirator and filter manufacturers' instructions
- VII. First-aid measures to take for urethane and urethane additive accidents
- A. Skin contact
 - 1. Remove contaminated clothing
 - 2. Immediately drench and flush affected skin with large quantities of water, and continue flushing for at least five minutes
 - B. Eye contact
 - 1. Position victim on affected side so that contaminated fluid does not run from affected eye into good eye
 - 2. Open eyelid with thumb and index finger, and flush eye for at least fifteen minutes by gently directing a stream of room-temperature water into inner side of eye

(NOTE: Flushing can be done with water from a water fountain, gently running hose, or faucet. Never use a hose fitted with a power nozzle.)

 - 3. Place sterile gauze pad over eyelid and face
 - 4. Transport victim to hospital at once
 - 5. Provide hospital personnel with label from contacted substance
 - C. Inhaled vapor or spray mist
 - 1. Remove victim to fresh air
 - 2. Loosen victim's tight clothing

EXAMPLES: Unbutton collar, unbuckle belt

 - 3. If victim is unconscious, direct someone to call the emergency squad while you keep an open airway and give artificial respiration or CPR if indicated
 - 4. Keep checking and assisting victim until medical help arrives
 - 5. Provide emergency personnel with label from inhaled substance

INFORMATION SHEET

VIII. Safety rules for paint room waste disposal

- A. Never pour combustible or flammable liquids into sink or floor drain
- B. Dispose of paints and thinners by placing in approved metal safety containers with self-sealing lids
- C. Dispose of solid wastes by placing in metal containers filled with water
(NOTE: Water helps to reduce the chance of spontaneous combustion.)
- D. Dispose of spray booth filters and rags by placing in approved metal safety containers with self-sealing lids

IX. Rules for safe use of disc sanders, grinders, and polishers

- A. Obey all safety instructions, and observe limitations on tool according to specifications and manufacturer's requirements
- B. Use correct tool for job being performed
- C. Wear approved eye protection
- D. Wear close-fitting clothing appropriate for job being performed
- E. Wear appropriate respirator or facemask
- F. Use tool only under dry conditions
(NOTE: Damp or wet areas can cause serious electrical shock.)
- G. Make sure that operating switch is off and that bonnet or disc faces up before connecting tool to power supply
- H. Make sure that disc or bonnet is not in contact with work surface when starting tool
- I. Keep a firm grip on tool at all times
- J. Exercise extra caution when operating tool near obstacles such as drip moldings, sharp panel edges, loose clips, or badly rusted areas that may catch, tear, or grab the disc and thus cause injury to operator
- K. Be cautious of sanding sparks near flammable or combustible materials
- L. Do not use abrasive discs at speeds in excess of recommended safe limits
- M. Be conscious of others' safety
- N. Make sure that disc or bonnet is in contact with work surface when stopping tool
- O. Disconnect power from tool before changing discs or attachments and before performing service or maintenance on tool

PAINT AND BODY SHOP SAFETY
UNIT III

ASSIGNMENT SHEET #1 — COMPLETE PAINT AND BODY SHOP SAFETY RULES

NAME _____ SCORE _____

Safety precautions and safety procedures must become a habit for the auto-body technician. The auto-body shop can be a healthy and safe place to work if safety is practiced by everyone involved in the shop operation. To obtain a high level of safety awareness, the technician needs to review and study basic safety rules.

Complete the following safety rules by writing the correct word or words in the blanks.

A. General safety rules

1. Ensure proper _____ and adequate air _____ in all spray-painting areas
2. Make sure that _____ are equipped with explosionproof lights, automatic sprinklers or fire extinguishers, and "No-Smoking" signs
3. Store creepers _____ when not in use
4. Use only nonsparking _____ in spray-painting areas
5. Use pressure of no more than _____ pounds per square inch (psi) for air hoses used to blow dirt off parts
6. Separate _____ operations from other work areas
7. When spray painting, wear a _____ approved for material being sprayed
8. Do not use _____ equipment in any spraying area subject to deposits of combustible residue

ASSIGNMENT SHEET #1

9. Keep spraying areas free of accumulated deposits of _____

10. Never try to _____ a leak in an air hose or hydraulic hose with
your _____
11. Perform cleaning, lubricating, and adjustment of equipment only after
_____ equipment from power source
12. Report defective _____ or _____ to your instructor
or supervisor

B. Safety rules for the prevention of fire and explosion

1. Do not _____ near gas tanks, fuel tanks, lacquer thinner, enamel
reducer, paint, or any combustible materials
2. Do not _____ electrical circuits
3. Do not use _____ or _____ electrical cords
4. Do not make any _____ repairs unless _____ by
the instructor
5. Do not run over _____ or drop-light cords
with vehicles, jacks, or creepers
6. Keep all solvent containers _____ except when pouring
7. Handle all solvents with care to avoid _____
8. Do not smoke, light matches, or use a torch in the _____

9. Always _____ painted vehicle from paint booth

ASSIGNMENT SHEET #1

10. Make sure that your hands and clothing are free of _____ or _____ before lighting matches or smoking
11. Hook a _____ from one container to another when transferring flammable liquids
12. Never _____ or attempt to _____ an empty thinner or reducer drum

C. Safety rules pertaining to batteries

1. Disconnect batteries when working on or near _____ and before _____ operations
2. Turn _____ battery charger before connecting or disconnecting charger cables
3. Keep all _____ away from batteries being charged
4. Never test the condition of a battery by _____ the _____
5. Do not leave battery charger on _____ for very long at one time
6. Do not charge a battery in a _____ room for very long without sufficient _____
7. Always observe _____ when servicing batteries
8. Handle battery _____ carefully, and keep it away from _____ and _____

ASSIGNMENT SHEET #1

D. Handling precautions for urethanes and urethane additives (isocyanates)

1. Read and observe product manufacturer's _____ and _____
2. Know that urethanes containing isocyanates are hazardous materials that may cause _____ irritation and allergic _____ reactions
3. Do not use isocyanates if you have _____ (long-term) lung or breathing problems
4. Use isocyanates only in a _____ - _____ area
5. Wear a _____ while spraying and until all _____ and _____ are gone
6. Wear a respirator containing only _____ for isocyanate vapors or mists
7. Follow all _____ and _____ manufacturers' instructions

E. Safety rules for paint room waste disposal

1. Never pour combustible or flammable liquids into _____ or _____
2. Dispose of paints and thinners by placing in approved _____ safety containers with _____ lids
3. Dispose of _____ by placing in metal containers filled with _____

ASSIGNMENT SHEET #1

4. Dispose of spray booth _____ and _____ by placing in approved _____ safety containers with _____ - _____ lids

F. Rules for safe use of disc sanders, grinders, and polishers

1. Obey all _____ , and observe _____ on tool according to specifications and manufacturer's requirements
2. Use _____ tool for job being performed
3. Wear approved _____ protection
4. Wear _____ - _____ clothing appropriate for job being performed
5. Wear appropriate _____ or facemask
6. Use tool only under _____ conditions
7. Make sure that operating switch is _____ and that bonnet or disc _____ before connecting tool to power supply
8. Make sure that disc or bonnet _____ in contact with _____ when starting tool
9. Keep a _____ on tool at all times
10. _____ when operating tool near obstacles such as drip moldings, sharp panel edges, loose clips, or badly rusted areas that may catch, tear, or grab the disc and thus cause injury to operator
11. Be cautious of _____ near flammable or combustible materials

ASSIGNMENT SHEET #1

12. Do not use _____ discs at _____ in excess of recommended safe limits
13. Be conscious of _____ safety
14. Make sure that disc or bonnet _____ contact with work surface when stopping tool
15. Disconnect power from tool before _____ discs or attachments and before performing _____ or _____ on tool

PAINT AND BODY SHOP SAFETY
UNIT III

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

- A. 1. Ventilation, circulation
 2. Paint booths
 3. Standing up
 4. Electric motors
 5. 30
 6. Spray finishing
7. Respirator
 8. Electrical
 9. Combustible residue
 10. Stop, hand
 11. Disconnecting
 12. Tools, equipment
- B. 1. Weld
 2. Overload
 3. Frayed, defective
 4. Electrical, supervised
 5. Extension cords
 6. Closed
7. Spillage
 8. Paint area
 9. Push
 10. Solvents, thinners
 11. Ground wire
 12. Puncture, weld
- C. 1. Electrical systems, charging
 2. Off
 3. Fire
 4. Shorting across, terminals
5. Fast charge
 6. Small, ventilation
 7. Correct polarity
 8. Acid, skin, clothing
- D. 1. Instructions, warnings
 2. Lung, respiratory
 3. Chronic
 4. Well-ventilated
5. Respirator, vapors, mists
 6. Filters approved
 7. Respirator, filter
- E. 1. Sink, floor drain
 2. Metal, self-sealing
3. Solid wastes, water
 4. Filters, rags, metal, self-sealing
- F. 1. Safety instructions, limitations
 2. Correct
 3. Eye
 4. Close-fitting
 5. Respirator
 6. Dry
 7. Off, faces up
 8. Is not, work surface
9. Firm grip
 10. Exercise extra caution
 11. Sanding sparks
 12. Abrasive, speeds
 13. Others'
 14. Is in
 15. Changing, service, maintenance

PAINT AND BODY SHOP SAFETY
UNIT III

TEST

NAME _____ SCORE _____

1. State six general safety rules for paint and body shop.

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

- f. _____

2. Match personal safety equipment to their correct uses. Write the correct numbers in the blanks. Uses are continued on the next page.

- | | |
|---|------------------------------|
| _____a. Worn for protection when there is danger of injury from falling or dropped objects | 1. Ear plugs or earmuffs |
| _____b. Worn for protection when using rotating machinery or flammable substances | 2. Respirator |
| _____c. Worn for protection when working with cleaners, acids, reducers, grinders and sharp edges, and when welding | 3. Safety shoes |
| _____d. Worn for protection when noise level exceeds 90 decibels | 4. Gloves |
| _____e. Worn for protection when sanding painted surfaces or sanding body filler | 5. Safety glasses or goggles |
| | 6. Dust mask |
| | 7. Close-fitting clothing |

TEST

- _____f. Worn for protection when cleaning parts, working beneath vehicles, handling chemicals, grinding, polishing, sanding, or welding
 - _____g. Worn for protection when working in any area contaminated with harmful dust, fogs, fumes, mists, gases, paints, or sprays
3. State five safety rules for the prevention of fire and explosion.
- a. _____

 - b. _____

 - c. _____

 - d. _____

 - e. _____

4. State four safety rules pertaining to batteries.
- a. _____

 - b. _____

 - c. _____

 - d. _____

TEST

5. Select from the following list guidelines for safe use of respirators. Write an "X" in the blank before each correct answer.

- _____ a. Use respirators for respiratory protection only in atmospheres containing dust, fumes, vapors, or sprays that *do not* pose an immediate threat to life or health
- _____ b. Use respirator equipped with air-purifying elements designed for protection against airborne particles when working with airborne particles
- _____ c. Use respirators for respiratory protection against vapors or gases that *lack adequate warning properties*, such as odor or irritating action
- _____ d. Use for protection against light amounts of vapors or gases respirators equipped with air-purifying elements designed only for protection against airborne particles
- _____ e. Use respirator equipped with air-purifying elements designed for protection against vapors and gases when working with vapors and gases

6. Select from the following list handling precautions for urethanes and urethane additives (isocyanates). Write an "X" in the blank before each correct answer.

- _____ a. Use your experience and judgment for instructions and warnings about use
- _____ b. Know that urethanes containing isocyanates are hazardous materials that may cause lung irritation and allergic respiratory reactions
- _____ c. Use an approved respirator if you have chronic (long-term) lung or breathing problems
- _____ d. Provide adequate ventilation if a respirator is not used
- _____ e. Wear a respirator while spraying and until all vapors and mists are gone
- _____ f. Wear a respirator containing only filters approved for isocyanate vapors or mists
- _____ g. Follow all respirator and filter manufacturers' instructions

7. State first-aid measures to take for urethane and urethane additive accidents.

Skin Contact

- a. _____

- b. _____

TEST

Eye Contact

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

Inhaled vapor or spray mist

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

8. State safety rules for paint room waste disposal.

- a. _____

TEST

- b. _____

- c. _____

- d. _____

9. Select from the following list rules for safe use of disc sanders, grinders, and polishers. Write an "X" in the blank before each correct answer.

- ____a. Wear approved eye protection
- ____b. Wear loose-fitting clothing for comfort and safety
- ____c. Connect power to tool before changing discs or attachments
- ____d. Be cautious of sanding sparks near flammable or combustible materials
- ____e. Make sure that disc or bonnet is not in contact with work surface when stopping tool
- ____f. Exercise extra caution when operating tool near obstacles such as drip moldings, sharp panel edges, loose clips, or badly rusted areas that may catch, tear, or grab the disc and thus cause injury to operator
- ____g. Make sure that operating switch is off and that bonnet or disc is in contact with work surface before connecting tool to power supply
- ____h. Do not use abrasive discs at speeds in excess of recommended safe limits
- ____i. Make sure that disc or bonnet is in contact with work surface when stopping tool
- ____j. Keep a firm grip on tool at all times
- ____k. Turn head sideways to prevent breathing grinding dust
- ____l. Be conscious of others' safety
- ____m. Use tool on a wet floor if you are wearing rubber-soled shoes
- ____n. Use correct tool for job being performed
- ____o. Obey all safety instructions, and observe limitations on tool according to specifications and manufacturer's requirements

PAINT AND BODY SHOP SAFETY
UNIT III

ANSWERS TO TEST

1. Answer should include any six of the following
 - a. Ensure proper ventilation and adequate air circulation in all spray-painting areas
 - b. Make sure that paint booths are equipped with explosionproof lights, automatic sprinklers or fire extinguishers, and "No-Smoking" signs
 - c. Store creepers standing up when not in use
 - d. Use only nonsparking electric motors in spray-painting areas
 - e. Use pressure of no more than 30 pounds per square inch (psi) for air hoses used to blow dirt off parts
 - f. Separate spray finishing operations from other work areas
 - g. When spray painting, wear respirator approved for material being sprayed
 - h. Do not use electrical equipment in any spraying area subject to deposits of combustible residue
 - i. Keep spraying areas free of accumulated deposits of combustible residue
 - j. Never try to stop a leak in an air hose or hydraulic hose with your hand
 - k. Perform cleaning, lubricating, and adjustment of equipment only after disconnecting equipment from power source.
 - l. Report defective tools or equipment to your instructor or supervisor

2.

a. 3	e. 6
b. 7	f. 5
c. 4	g. 2
d. 1	

3. Answer should include any five of the following
 - a. Do not weld near gas tanks, fuel lines, lacquer thinner, enamel reducer, paint, or any combustible materials
 - b. Do not overload electrical circuits
 - c. Do not use frayed or defective electrical cords
 - d. Do not make any electrical repairs unless supervised by the instructor
 - e. Do not run over extension cords or drop-light cords with vehicles, jacks, or creepers
 - f. Keep all solvent containers closed except when pouring
 - g. Handle all solvents with care to avoid spillage
 - h. Do not smoke, light matches, or use a torch in the paint area
 - i. Always *push* painted vehicle from paint booth
 - j. Make sure that your hands and clothing are free of solvents or thinners before lighting matches or smoking
 - k. Hook a ground wire from one container to another when transferring flammable liquids
 - l. Never puncture or attempt to weld an empty thinner or reducer drum

ANSWERS TO TEST

4. Answer should include any four of the following
 - a. Disconnect batteries when working on or near electrical systems and before charging operations
 - b. Turn off battery charger before connecting or disconnecting charger cables
 - c. Keep all fire away from batteries being charged
 - d. Never test the condition of a battery by shorting across terminals
 - e. Do not leave battery charger on "fast charge" for very long at one time
 - f. Do not charge battery in a small room for very long without sufficient ventilation
 - g. Always observe correct polarity when servicing batteries
 - h. Handle battery acid carefully and keep it away from skin and clothing

5. a, b, e

6. b, e, f, g

7. **Skin contact**
 - a. Remove contaminated clothing
 - b. Immediately drench and flush affected skin with large quantities of water, and continue flushing for at least five minutes

Eye contact

 - a. Position victim on affected side so that contaminated fluid does not run from affected eye into good eye
 - b. Open eyelid with thumb and index finger, and flush eye for at least fifteen minutes by gently directing a stream of room-temperature water into inner side of eye
 - c. Place sterile gauze pad over eyelid and face
 - d. Transport victim to hospital at once
 - e. Provide hospital personnel with label from contacted substance

Inhaled vapor or spray mist

 - a. Remove victim to fresh air
 - b. Loosen victim's tight clothing
 - c. If victim is unconscious, direct someone to call the emergency squad while you keep an open airway and give artificial respiration or CPR if indicated
 - d. Keep checking and assisting victim until medical help arrives
 - e. Provide emergency personnel with label from inhaled substance

8.
 - a. Never pour combustible or flammable liquids into sink or floor drain
 - b. Dispose of paints and thinners by placing in approved metal safety containers with self-sealing lids
 - c. Dispose of solid wastes by placing in metal containers filled with water
 - d. Dispose of spray-booth filters and rags by placing in approved metal safety containers with self-sealing lids

9. a, d, f, h, i, j, l, n, o

MATH AND MEASURING UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to solve basic math problems and read a rule. The student will show this knowledge by completing assignment sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with math and measuring.
2. Match to their correct names symbols used in math problems.
3. Label the place values of a whole number.
4. Add whole numbers.
5. Subtract whole numbers.
6. Multiply whole numbers.
7. Divide whole numbers.
8. Distinguish among types of fractions.
9. Reduce fractions to lowest terms.
10. Convert mixed numbers to improper fractions.
11. Convert improper fractions to mixed numbers.
12. Add fractions.
13. Subtract fractions.
14. Multiply fractions.
15. Divide fractions.
16. Label the place values of a decimal number.
17. Add decimal numbers.
18. Subtract decimal numbers.

OBJECTIVE SHEET

19. Multiply decimal numbers.
20. Divide decimal numbers.
21. Convert fractions to decimal numbers and percentages.
22. Identify decimal and fractional equivalents.
23. Convert percentages to fractions and decimal numbers.
24. Solve percentage problems.
25. Solve basic ratio and proportion problems.
26. Identify graduations on a rule.
27. Read a rule to the nearest fraction of an inch.

MATH AND MEASURING UNIT IV

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 1. Supplements
 - a. Supplement #1 — Crossword Puzzle of Math Terms
 - b. Supplement #2 — Subtraction Squares
 2. Answers to supplements
 - C. Transparency masters
 1. TM #1 — Ratio and Proportion
 2. TM #2 — Graduations on a Rule
 3. TM #3 — Graduations on a Rule (Continued)
 4. TM #4 — Reading Fourths on a Rule
 5. TM #5 — Reading Eighths on a Rule
 6. TM #6 — Reading Sixteenths on a Rule
 - D. Information sheet
 - E. Assignment sheets
 1. Assignment Sheet #1 — Add Whole Numbers
 2. Assignment Sheet #2 — Subtract Whole Numbers
 3. Assignment Sheet #3 — Multiply Whole Numbers
 4. Assignment Sheet #4 — Divide Whole Numbers
 5. Assignment Sheet #5 — Work with Fractions
 6. Assignment Sheet #6 — Reduce Fractions to Lowest Terms
 7. Assignment Sheet #7 — Convert Unlike Fractions to Like Fractions
 8. Assignment Sheet #8 — Convert Fractions and Mixed Numbers

SUGGESTED ACTIVITIES

9. Assignment Sheet #9 — Add Fractions
10. Assignment Sheet #10 — Subtract Fractions
11. Assignment Sheet #11 — Multiply Fractions
12. Assignment Sheet #12 — Divide Fractions
13. Assignment Sheet #13 — Add Decimal Numbers
14. Assignment Sheet #14 — Subtract Decimal Numbers
15. Assignment Sheet #15 — Multiply Decimal Numbers
16. Assignment Sheet #16 — Divide Decimal Numbers
17. Assignment Sheet #17 — Convert Fractions and Percentages
18. Assignment Sheet #18 — Solve Percentage Problems
19. Assignment Sheet #19 — Solve Basic Ratio and Proportion Problems
20. Assignment Sheet #20 — Read Measurements on a Rule

F. Answers to assignment sheets

G. Test

H. Answers to test

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials to supplement unit.

1. Films

2. Books

- a. *Speaking of Numbers*. This self-instructional workbook/textbook series is intended for use with two groups of students: 1) beginning English-as-a-Second-Language students, who are concurrently studying English and basic mathematic skills; and 2) native speakers of English who require remediation and reinforcement in numbers and arithmetic operations.

(NOTE: *Speaking of Numbers* is available from the Institute of Modern Languages, 2622 Pittman Drive, Silver Spring, Maryland 20910.)

SUGGESTED ACTIVITIES

- b. *Math*. This book is part of a series of manuals developed specifically for special needs programs for disadvantaged and handicapped students. Seven areas of instruction have assignment sheets specifically designed to acquaint students with basic and practical mathematical problems and terms directly related to vocational skill trades. The guide contains instruction in measurement, whole numbers, fractions, decimals, percentages, consumer education, and geometry.

(NOTE: *Math* is available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

3. Transparencies and competency profiles

(NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

- C. Make additional transparencies and additional copies of assignment sheets and supplements if needed.
- D. Use the assignment sheets (of parts of them) to pretest students in each math concept. Those students who demonstrate proficiency and an understanding of the concept may use the assignment sheets as a review or may be paired with those students who need help in mastering the concepts.

(NOTE: It is suggested that this unit be taught as an outside assignment for those students who did not successfully complete the pretest.)

- E. Provide students with unit.
- F. Discuss unit and specific objectives.

1. Introduce unit by stressing the importance of mathematics in the auto-body shop and in basic life skills.

SUGGESTIONS:

- Explain that the lasting success of a finish job may be determined by the accuracy of the mathematics used by the technician during preparation of filler and finish materials.
 - Stress the importance of mathematics in cost control.
2. Discuss the technological explosion presently underway in the world and its effects on our lives. Emphasize the increased demand for technical skills.

SUGGESTED ACTIVITIES

3. Point out that an understanding of mathematical concepts, a grasp of analytical logic, accuracy in computational skills, and the ability to apply these skills to a wide variety of situations are essential to getting and keeping a job.

G. Discuss information and assignment sheets.

1. Use Information Sheet, Section I to discuss terms associated with math and measuring.

SUGGESTIONS:

- Relate terms to auto-body trade usage.
- Point out the importance of defining terms for common understanding.
- Have students complete Supplement #1 as a review of terms.

2. Use Information Sheet, Section II to discuss symbols used in math problems.

SUGGESTIONS:

- Prepare examples of problems using the symbols.
- Have students discuss where they have seen the math symbols used.

3. Use Information Sheet, Sections III and IV and Assignment Sheet #1 to discuss addition.

SUGGESTIONS:

- Play "You Inherit" with the students to help them learn place values. Ask students to tell you the least amount they inherit when you give them the amount in numbers of digits.

EXAMPLE: Q. You have just inherited a six-digit sum. What is the least amount you inherit?

A. One hundred thousand dollars

- Prepare groups of objects such as bottle caps, books, tacks, nails, boards, and crayons to be added at different tables. Have students stop at each table and perform the addition as directed. Provide each student with a work sheet on which the equation and answer could be written.

(NOTE: Similar situations could be set up for subtraction.)

- Have students play dominoes. Score ends in multiples of five and play to 250, or score ends at end of each turn and play to 1,000 points.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section V and Assignment Sheet #2 to discuss subtraction.

SUGGESTIONS:

- Develop a set of flash cards containing various subtraction problems. Show students each card and have them give you the correct answer, either orally or written on a sheet of paper.
- Use spinner and game boards. Each student spins twice, writes down each number, subtracts the difference and moves the marker the appropriate number of jumps.
- Have students practice subtraction by completing Supplement #2.

(NOTE: You may want to prepare similar squares for addition, multiplication, and division with whole numbers, fractions, or decimals; or for calculations with exponents and square roots of the perfect square.)

5. Use Information Sheet, Section VI and Assignment Sheet #3 to discuss multiplication.

SUGGESTIONS:

- Obtain or make multiplication table to 12. Have students learn the table.
- Sit students in a circle. Have all students clap hands twice on legs, then clap hands together twice, then snap fingers twice to establish a rhythm that is to continue unbroken throughout the game. The caller gives a multiplication (or other operation) problem such as 8×6 while snapping fingers, and at the next finger snapping says the name of someone to answer the problem. The responder gives answer at next finger snapping without breaking the clap/snap rhythm. If the responder maintains the rhythm and gives the correct answer, then he or she becomes the next caller. If the responder breaks the rhythm or gives an incorrect answer, then he or she is out of the game. The last person left is the winner.

6. Use Information Sheet, Section VII and Assignment Sheet #4 to discuss division.

SUGGESTION:

- For students who consistently cannot make the appropriate decisions to solve long-division exercises, try the "decision-free," step-by-step procedure on the next page.

SUGGESTED ACTIVITIES

- | | | |
|---|------------------------|----------|
| a. Copy the problem. | 52 $\overline{)86310}$ | |
| | <u>52000</u> | 1000 |
| b. Draw a vertical line to the right of the problem. | 34310 | |
| | <u>20800</u> | 400 |
| | 13510 | |
| c. Make a guess and write that down to the right of the vertical line. | <u>10400</u> | 200 |
| | 3110 | |
| | <u>2600</u> | 50 |
| d. Multiply the guess by the divisor and subtract from the original number. | 510 | |
| | <u>416</u> | 8 |
| | 94 | |
| e. Repeat the process until subtracting produces a number smaller than divisor. | <u>52</u> | <u>1</u> |
| | 42 | 1659 |
- f. The answer is the sum of the guesses.
- g. Check by multiplying the answer times the divisor and adding the remainder. If the problem has been solved correctly, the resulting sum should equal the original number inside the division frame.

EXAMPLE:	1659	Answer
	$\times 52$	Divisor
	<u>3318</u>	
	<u>8295</u>	
	86268	
	<u>+ 42</u>	Remainder
	86310	Sum Equal to Original Number

7. Use Information Sheet, Section VIII, and Assignment Sheet #5 to discuss types of fractions.

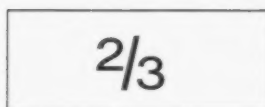
SUGGESTIONS:

- Write a proper fraction, such as $\frac{3}{8}$, on the chalkboard. Label the fraction's nominator and denominator. Explain that the denominator of this (or any) fraction represents the way the unit has been split. Illustrate this point by drawing on the chalkboard a circle split into eight parts. Now explain that the numerator of this (or any) fraction represents the number of parts involved in the calculation. Therefore the fraction $\frac{3}{8}$ indicates three parts of something that has been divided into eight parts. Shade in three of the eight parts of the circle to illustrate this point.

SUGGESTED ACTIVITIES

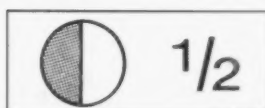
- Make two decks of cards. Show fractions on one deck and the corresponding pictures on the other deck.

EXAMPLE:



Cards can also be made to show equivalent fractions, using pictures and fractions.

EXAMPLE:



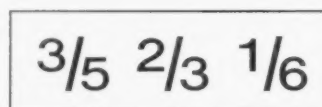
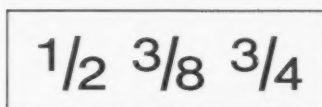
Students may play a game of matching or rummy by making pairs that match.

8. Use Information Sheet, Section IX and Assignment Sheets #6 and #7 to discuss reducing fractions to the lowest terms and converting unlike fractions to like fractions.

SUGGESTIONS:

- Prepare twenty-four tagboard flash cards. On each card, write two or three unlike fractions.

EXAMPLES:



Laminate the cards. Have students number their papers from 1 to 24; then give them fifteen seconds to write the least common denominator for the fractions on each flash card shown. To increase the difficulty, shorten the time-span for calculating each lowest common denominator.

- Use these flash cards to review addition, subtraction, and multiplication of fractions.

SUGGESTED ACTIVITIES

9. Use Information Sheet, Sections X and XI and Assignment Sheet #8 to discuss converting mixed numbers to improper fractions and converting improper fractions to mixed numbers.

SUGGESTION:

- Have students practice measuring with rules by measuring various items in the classroom: length of books, length and width of desk or table, height of chairs, length of pencil, and so on. Have students record their measurements on a sheet of paper, and then have them convert their measurements into improper fractions. After they have the improper fractions, have them give their lists to another student who then converts the improper fractions to mixed numbers.
10. Use Information Sheet, Section XII and Assignment Sheet #9 to discuss adding fractions.
 11. Use Information Sheet, Section XIII and Assignment Sheet #10 to discuss subtracting fractions.
 12. Use Information Sheet, Section XIV and Assignment Sheet #11 to discuss multiplying fractions.
 13. Use Information Sheet, Section XV and Assignment Sheet #12 to discuss dividing fractions.
 14. Use Information Sheet, Section XVI to discuss the place values of decimals.

SUGGESTION:

- Have students write down several decimal numbers. Have students write out the decimal number by place values, i.e., tenths, hundredths, thousandths, ten thousandths, millionths.
15. Use Information Sheet, Section XVII and Assignment Sheet #13 to discuss adding decimal numbers.

SUGGESTION:

- Assign a monetary value to each letter of the alphabet: A = \$0.50, B = \$1.00, C = \$1.50 . . . Z = \$13.00. Then have students calculate such problems as who has the most valuable name? What auto-body hand tool has the most valuable name? What auto-body power tool has the most valuable name?

(NOTE: This activity can be adapted and used to practice multiplication of whole numbers, or for practice with fractions.)

SUGGESTED ACTIVITIES

16. Use Information Sheet, Section XVIII and Assignment Sheet #14 to discuss subtracting decimal numbers. Emphasize the importance of checking answers.
17. Use Information Sheet, Section XIX and Assignment Sheet #15 to discuss multiplying decimal numbers.

SUGGESTION:

- Increase student speed in certain multiplication problems by giving timed tests in which the student must use the following shortcuts.

To multiply by

5, 50, 500 etc., just multiply by 10, 100, 1000, etc., and divide by 2;

25, 250, 2500, etc., just multiply by 100, 1000, etc., and divide by 4;

$33\frac{1}{3}$, $16\frac{2}{3}$, $12\frac{1}{2}$, $8\frac{1}{3}$, $6\frac{1}{4}$ multiply by 100 and divide by 3, 6, 8, 12, 16, respectively.

18. Use Information Sheet, Section XX and Assignment Sheet #16 to discuss dividing decimal numbers.

SUGGESTION:

- Increase student speed in certain division problems by giving timed tests in which students use the following shortcuts.

To divide by

$3\frac{1}{3}$, multiply by 3 and divide by 10;

$33\frac{1}{3}$, multiply by 3 and divide by 100;

$16\frac{2}{3}$, multiply by 6 and divide by 100;

25, multiply by 4 and divide by 100;

50, multiply by 2 and divide by 100.

(NOTE: There are other shortcuts that you may want to add to this list and the list of multiplication shortcuts.)

19. Use Information Sheet, Sections XXI through XXIV and Assignment Sheets #17 and #18 to discuss fractional equivalents and the conversion of fractions and decimals.

SUGGESTIONS:

- Before presenting rules for converting fractions to decimals, have students solve problems by converting the decimals to fractions. The answer from the computation with the equivalent fractions must then be converted back to a decimal form. A half dozen exercises like this for each decimal rule may help students appreciate the benefits of learning the rules and why the decimal rules work.

SUGGESTED ACTIVITIES

$$\begin{aligned}
 \text{EXAMPLE: } 5.67 + 3.2 + 4.104 &= 5 \frac{670}{1000} + 3 \frac{200}{1000} + 4 \frac{104}{1000} \\
 &= 12 \frac{974}{1000} \\
 &= 12.974
 \end{aligned}$$

- Obtain a set of twist drills and a drill index. Take the drills out of the drill index. Have students replace drills in the index, noting the decimal and fractional differences in the drill sizes.
 - Obtain a quantity of pocket-sized decimal equivalent charts from your local tool supplier. Give one to each student.
 - Illustrate percentages by providing students with graph or grid paper. Have students outline at least eight 10-by-10-block squares. Since each block contains 100 units or small squares, students can shade in enough units to illustrate 25 percent, $33\frac{1}{3}$ percent, 50 percent, 96 percent, and so on.
20. Use Information Sheet, Section XXV and Assignment Sheet #19 to discuss ratio and proportion.

SUGGESTION:

- Use Transparency #1 to illustrate ratio and proportion.
21. Use Information Sheet, Section XXVI to discuss the graduations on a rule.

SUGGESTION:

- Illustrate your discussion with Transparency #2.
22. Use Information Sheet, Sections XXVII to discuss reading a rule.

SUGGESTIONS:

- Use Transparencies #3 through #5 to help explain the relationships among the different graduations on a rule.
- Have students complete Assignment Sheet #20 so that they may practice reading a rule and measuring objects.

H. Give test.

(NOTE: It is recommended that this test be given in parts, such as the math processes, fractions, and decimals.)

SUGGESTED ACTIVITIES

- I. Critique test and discuss in class.
 - J. Reteach if necessary.
 - K. Complete appropriate section of competency profiles.
- III. Unit references
- A. Gossage, Loyce G., and Milton Briggs. *Basic Mathematics Review*. Cincinnati, Ohio: South-Western Publishing Co., 1969.
 - B. Hendrix, Laborn J. "Bud." *Bricklaying Curriculum: Basic Core*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1983.
 - C. Hendrix, Laborn J. "Bud." *Fundamentals of Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1985.
 - D. Martinka, Marie. *Vocational Mathematics for Business*. Cincinnati, Ohio. South-Western Publishing Company, 1978.
 - E. *Math One*. Oklahoma City, Oklahoma: Oklahoma Department of Transportation, 1970.
 - F. Morrison, Phyllis. *Basic Math Skills*. New York: McGraw-Hill Book Company, 1972.
 - G. Turcotte, Raymond J. *Bricklaying Curriculum Instructional Units*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1977.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — CROSSWORD PUZZLE OF MATH TERMS

NAME _____

SCORE _____

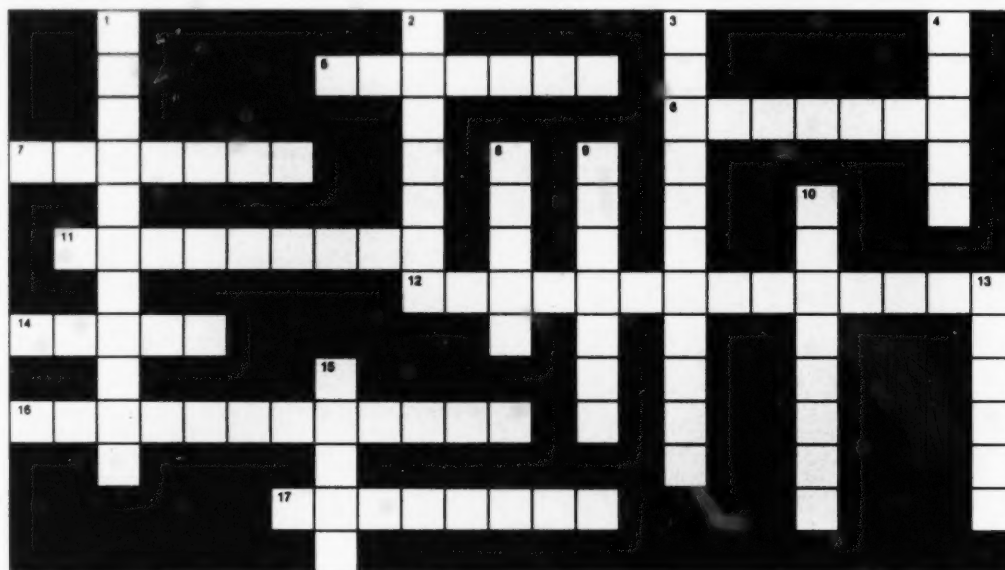
To help you review the terms used in this unit, use the clues below to complete the following crossword puzzle.

ACROSS

5. One part in a hundred; reckoned on the basis of a whole divided into one hundred parts
6. Pertaining to nominal units based on a 4-inch module
7. Any of the natural numbers; the whole numbers, positive and negative
11. To solve by mathematical process
12. Abbreviated process of adding an integer to itself a specified number of times
14. Relationship in quantity, amount, or size between two or more things; expressed with ratio symbol
16. Being relatively equal in size or quantity
17. Opposite (inverse) operation of multiplication

DOWN

1. Opposite (inverse) operation of addition
2. Mathematical proposition
3. Theoretical size that may vary from the actual (2 wds.)
4. Inverted "V" symbol used to indicate where something is to be inserted
8. With 13 Down, any of the integers that represents a complete item
9. Fraction with an unwritten denominator of 10 or some power of 10, indicated with a point before the numerator
10. Part of a whole; represents one or more equal parts of a unit
13. See 8 Down
15. Any one of the ten symbols, 0 to 9, by which all numbers can be expressed



SUGGESTED ACTIVITIES

SUPPLEMENT #2 — SUBTRACTION SQUARES

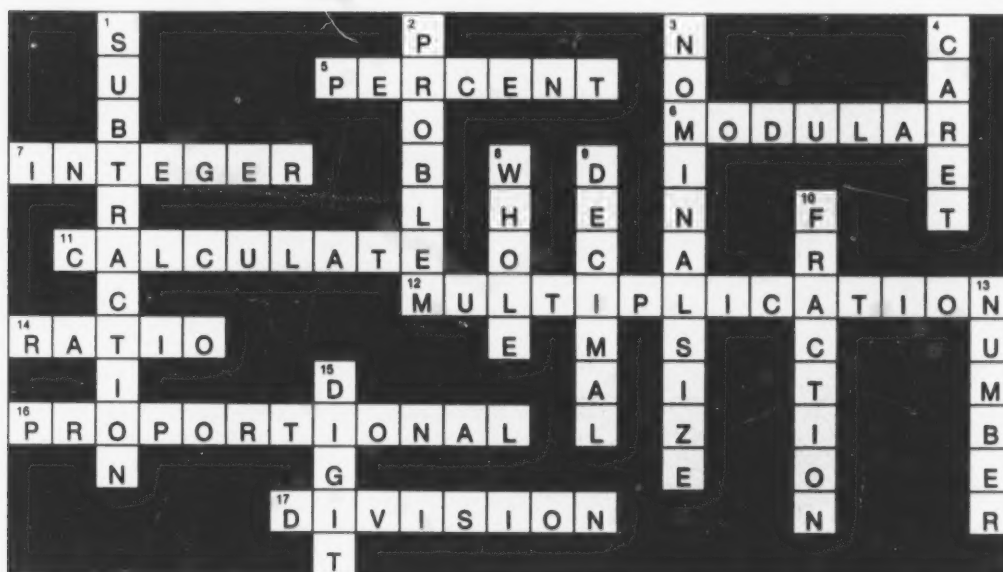
Cut out the sixteen squares shown below and then fit them together so that the edges that touch form a problem and its correct solution. For better durability, glue the sheet to heavy poster board before cutting out squares.

10-5 6 9-1 8-1	8 10-7 15-5 12-2	9-4 5 11-2 2	
6 6-2 12-6 10-2	7 10 6-4 9-6	4-0 7 0 12-3	
7-4 2 4	3 10-6 9-2	10 8-3 4	4 3 5
9 8 3	1 8-8 5	9 7-6 9-3	8-6 4 7-3

SUGGESTED ACTIVITIES

ANSWERS TO SUPPLEMENTS

Supplement #1



ANSWERS TO SUPPLEMENTS

Supplement #2

11-2	9	7-6	1	8-8	0
2	9-3	5	12-3		
8-6	6	10-5	9		
4	6-2	12-6	6	9-1	8
7-3	10-2	8-1	3		
4	8	7	7-4		
3	10-7	15-5	10	6-4	2
5	12-2	9-6	4		
9-4	10	3	4-0		
5	8-3	4	10-6	9-2	7

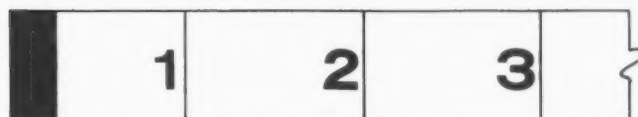
Ratio and Proportion

**1:1:3 = Ratio of Reducer,
Pigment, and Enamel
in Paint Mix**

**.5:.5:1.5 = Proportion of Ratio
1:1:3 Cut in Half**

Graduations on a Rule

Inches



Halves



Quarters or Fourths



Graduations on a Rule

(Continued)

Eighths



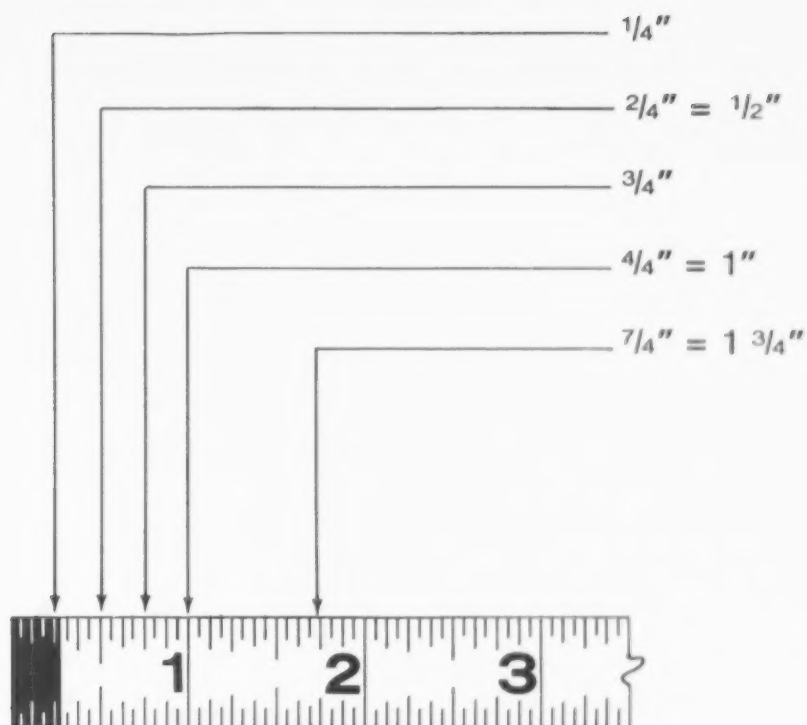
Sixteenths



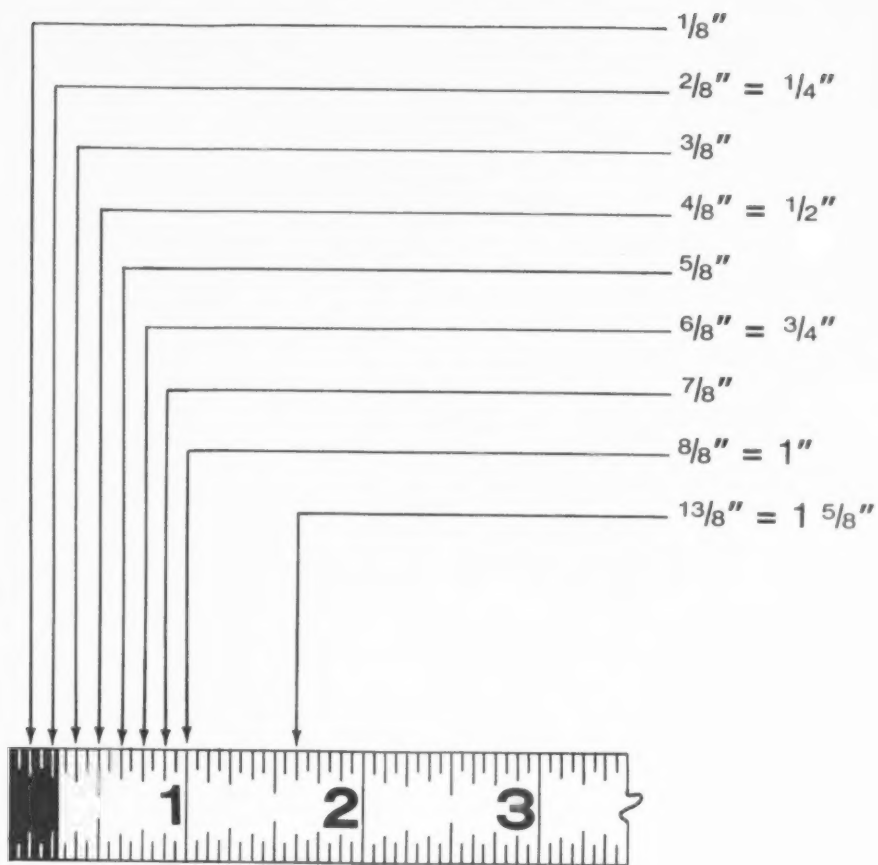
Thirty-Seconds



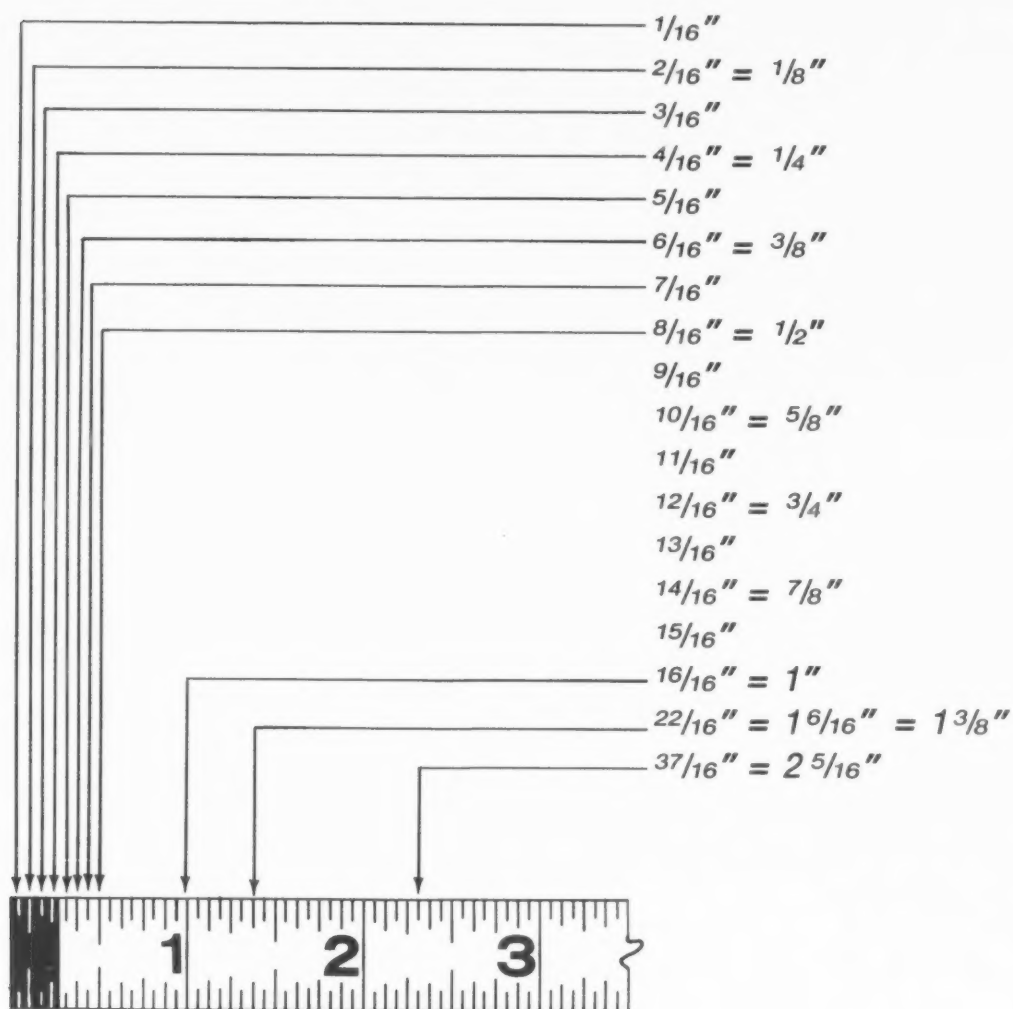
Reading Fourths on a Rule



Reading Eighths on a Rule



Reading Sixteenths on a Rule



MATH AND MEASURING UNIT IV

INFORMATION SHEET

I. Terms and definitions

- A. Whole number (integer) — Any of the natural numbers, both positive and negative, that represents a complete item

EXAMPLE: 25 is a whole number as opposed to $\frac{3}{4}$, a fraction or part of a whole.

- B. Digit — Any one of the ten symbols, 0 to 9, by which all numbers can be expressed

- C. Fraction — Part of a whole; represents one or more equal parts of a unit (Figures 1 and 2)

EXAMPLES: $\frac{1}{2}$, $\frac{3}{8}$, $\frac{1}{4}$, $\frac{3}{16}$

FIGURE 1

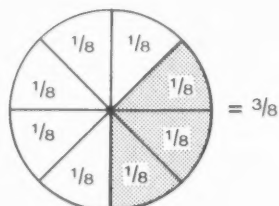
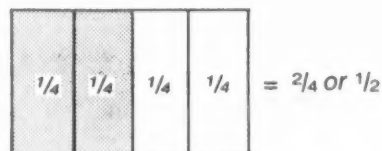


FIGURE 2



- D. Decimal — Fraction with an unwritten denominator of 10 or some power of 10; indicated with a point before the number

EXAMPLES: $0.1 = \frac{1}{10}$
 $0.06 = \frac{6}{100}$
 $0.003 = \frac{3}{1000}$

- E. Addition — Process of totaling two or more numbers to find another number called a sum

EXAMPLE: $3 + 5 + 9 = 17$

- F. Subtraction — Opposite (inverse) operation of addition

EXAMPLE: $8 - 4 = 4$ as opposed to $4 + 4 = 8$

- G. Multiplication — Abbreviated process of adding a number to itself a specified number of times

EXAMPLE: $6 \times 3 = 18$ as opposed to $6 + 6 + 6 = 18$

INFORMATION SHEET

H. Division — Opposite (inverse) operation of multiplication

EXAMPLE: $16 \div 2 = 8$ as opposed to $8 \times 2 = 16$

I. Percent — One part in a hundred; reckoned on the basis of a whole divided into one hundred parts

J. Ratio — Relationship in quantity, amount, or size between two or more things

K. Proportional — Being relatively equal in size or quantity

EXAMPLE: $1:1:3 = 0.5:0.5:1.5$

II. Symbols used with math problems (Table 1)

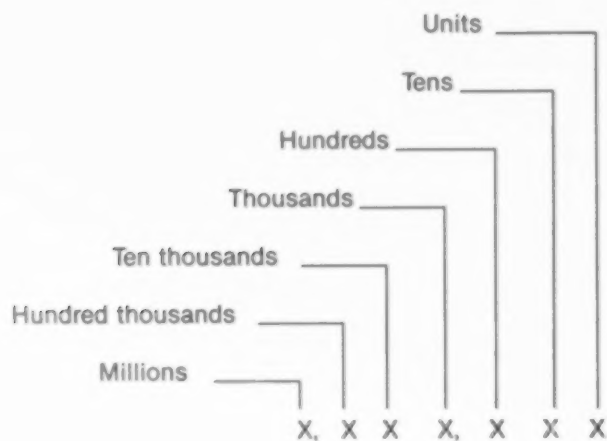
TABLE 1

Name of Symbol	Symbol
Plus sign (addition)	+
Minus sign (subtraction)	-
Times sign (multiplication)	$\times$
Division sign	$\div$
Division frame	$\overline{) }$
Equal sign	=
Decimal point	.
Percent symbol	%
Ratio symbol	:
Pi sign	π

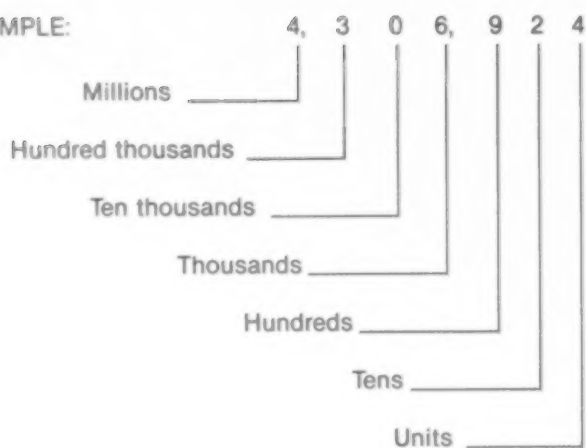
INFORMATION SHEET

III. Place values of a number

(NOTE: The position of a digit in a number shows how much that digit is worth. These positions are called *place values*.)



EXAMPLE:



(NOTE: The number in this example is four million, three hundred six thousand, nine hundred twenty-four.)

INFORMATION SHEET

IV. Adding whole numbers

- A. Set up problem by writing units under units, tens under tens, and so on

EXAMPLE: Add the whole numbers 1632, 17, 550.

$$\begin{array}{r} 1632 \\ 17 \\ + 550 \\ \hline \end{array}$$

- B. Add each column separately, beginning at top of units column

EXAMPLE:	$\begin{array}{r} 1632 \\ 17 \\ + 550 \\ \hline 9 \end{array}$	$\begin{array}{r} 1632 \\ 17 \\ + 550 \\ \hline 99 \end{array}$
----------	--	---

- C. If the sum of any column is two or more digits, write the units digit in your answer and carrying the remaining digit(s) to the top of next column to the left

EXAMPLE:		$\begin{array}{r} 1632 \\ 17 \\ + 550 \\ \hline 199 \end{array}$	$\begin{array}{r} 1 \\ 1632 \\ 17 \\ + 550 \\ \hline 199 \end{array}$	← Carry remaining digit.
	Write units digit. →			

- D. Add any carried digit(s) above the column with that column

EXAMPLE:	$\begin{array}{r} 1 \\ 1632 \\ 17 \\ + 550 \\ \hline 2199 \end{array}$	Carried Digit
----------	--	---------------

V. Subtracting whole numbers

- A. Set up problem by writing units under units, tens under tens, and so on

(NOTE: The top number in the problem [original number] is almost always larger than the bottom number [subtracted number].)

EXAMPLE: Subtract 91 from 123.

$\begin{array}{r} 123 \\ - 91 \\ \hline \end{array}$	Original Number Subtracted Number
--	--------------------------------------

- B. Subtract each column separately, beginning at bottom of units column

EXAMPLE:	$\begin{array}{r} 123 \\ - 91 \\ \hline 2 \end{array}$
----------	--

INFORMATION SHEET

- C. If a digit in the subtracted number is larger than the digit above it, "borrow" 1 from the top digit in the next column to the left, decreasing that digit by one and increasing the digit being subtracted from by ten

EXAMPLE:
$$\begin{array}{r} \overset{0}{\cancel{2}}3 \\ - 91 \\ \hline 32 \end{array}$$

- D. If there is nothing to borrow in the next left column (column contains a zero), first borrow for that column from its next left column

EXAMPLE:

$$\begin{array}{r} \overset{8}{\cancel{0}}\overset{10}{\cancel{0}}6 \\ - 318 \\ \hline \end{array}$$

$$\begin{array}{r} \overset{9}{\cancel{0}}\overset{10}{\cancel{0}}6 \\ - 318 \\ \hline 8 \end{array}$$

$$\begin{array}{r} \overset{9}{\cancel{0}}\overset{10}{\cancel{0}}6 \\ - 318 \\ \hline 88 \end{array}$$

$$\begin{array}{r} \overset{9}{\cancel{0}}\overset{10}{\cancel{0}}6 \\ - 318 \\ \hline 588 \end{array}$$

- E. Check your subtraction by adding your answer to the subtracted number

EXAMPLE:

	Problem		Check
271	Original Number	271	Original Number
- 164	Subtracted Number	- 164	
107	Answer	+ 107	Check Answer
		271	

(NOTE: If you have solved the problem correctly, your check answer should be the same as the original number.)

VI. Multiplying whole numbers

- A. Set up problem by writing the larger number (original number) above the smaller number (multiplier), writing units under units, tens under tens, and so on

(NOTE: You will get the correct answer [product] no matter which number is placed above the other, but the faster method places the larger above the smaller.)

EXAMPLE: Multiply the numbers 53 and 4.

$$\begin{array}{r} 53 \text{ Original Number} \\ \times 4 \text{ Multiplier} \\ \hline \end{array}$$

INFORMATION SHEET

- B. If the multiplier contains only one digit, multiply each digit in the original number by it, working from right to left

1. Multiply units digit in original number by multiplier
2. Write answer units digit and insert necessary carry digit above next left column in original number as required

EXAMPLE:

$$\begin{array}{r} 1 \\ 53 \\ \uparrow \\ \times 4 \\ \hline 2 \end{array}$$

3. Multiply tens digit by multiplier and add carried digit as required

EXAMPLE:

$$\begin{array}{r} 1 \\ 53 \\ \swarrow \\ + 4 \\ \hline 212 \end{array}$$

- C. If the multiplier contains more than one digit, find partial products

1. Multiply each digit in original number by each digit in multiplier, moving from right to left
2. Align partial products so that right-hand digit of each is directly under its corresponding digit in the multiplier

EXAMPLE: Multiply the numbers 174 and 42.

$\begin{array}{r} 174 \\ \uparrow \\ \times 42 \\ \hline 8 \end{array}$	$\begin{array}{r} 1 \\ 174 \\ \swarrow \\ \times 42 \\ \hline 48 \end{array}$	$\begin{array}{r} 1 \\ 174 \\ \swarrow \\ \times 42 \\ \hline 348 \end{array}$	$\begin{array}{r} 1 \\ 174 \\ \swarrow \\ \times 42 \\ \hline 348 \\ 6 \end{array}$	$\begin{array}{r} 21 \\ 174 \\ \uparrow \\ \times 42 \\ \hline 348 \\ 96 \end{array}$	$\begin{array}{r} 2 \\ 174 \\ \swarrow \\ \times 42 \\ \hline 348 \\ 696 \end{array}$
		$\uparrow$ First Partial Product		$\uparrow$ Second Partial Product	

- D. Add the partial products

EXAMPLE:

$$\begin{array}{r} 174 \\ \times 42 \\ \hline 348 \\ + 696 \\ \hline 7308 \end{array}$$

7308 — Answer (Product)

178

INFORMATION SHEET

VII. Dividing whole numbers

- A. Set up problem by writing original number (number to be divided) inside a division frame, and by writing divisor (number you are dividing by) outside frame

EXAMPLE: How many times will 33 go into 3347?

Divisor 33 $\overline{)3347}$ Original Number

- B. Determine how many times the divisor will go into the first digit of the original number; if it will not, write a zero in the answer space directly above the first digit, and then determine how many times the divisor will go into the first two numbers of the original number

(NOTE: Continue trying to divide the original number by the divisor until a set of digits can be divided. Remember to write a zero each time the set of digits cannot be divided.)

EXAMPLE: $\begin{array}{r} 0 \\ 34 \overline{)3347} \end{array}$ 34 goes into 3 zero times.

$\begin{array}{r} 00 \\ 34 \overline{)3347} \end{array}$ 34 goes into 33 zero times.

$\begin{array}{r} 009 \\ 34 \overline{)3347} \end{array}$ 34 goes into 334 nine times.

- C. Multiply the divisor by the answer (digit above frame); write this answer under the digit(s) that divisor went into, and subtract

EXAMPLE: $\begin{array}{r} 34 \\ \times 9 \\ \hline 306 \end{array}$ Multiply divisor (34) by answer (9).

$\begin{array}{r} 009 \\ 34 \overline{)3347} \\ - 306 \\ \hline 28 \end{array}$ Write answer under 334, the digits divisor went into, and subtract.

- D. Bring down next unused digit from original number, and place it to the right of the subtracted difference (remainder)—even if the remainder is zero

EXAMPLE: $\begin{array}{r} 009 \\ 34 \overline{)3347} \\ \underline{306} \\ 287 \end{array}$

INFORMATION SHEET

- E. Determine how many times the divisor will go into this new number; write your answer in the answer space above the digit that was brought down

EXAMPLE:
$$\begin{array}{r} 0098 \\ 34 \overline{)3347} \\ \underline{306} \\ 287 \end{array}$$

- F. Multiply the divisor by the last digit you wrote in the answer; write this product under the digits that divisor went into, and subtract

EXAMPLE:
$$\begin{array}{r} 34 \\ \times 8 \\ \hline 272 \end{array}$$
 Multiply divisor (34) by last digit of answer (8).

$$\begin{array}{r} 0098 \\ 34 \overline{)3347} \\ \underline{306} \\ 287 \\ - \underline{272} \\ 15 \end{array}$$
 Write product under 287, the digits that divisor went into, and subtract.

- G. Continue this process until all numbers in the original number are used
- H. Write any remaining subtracted difference as a remainder

EXAMPLE:
$$\begin{array}{r} 0098 \\ 34 \overline{)3347} \\ \underline{306} \\ 287 \\ \underline{272} \\ 15 \text{ Remainder} \end{array}$$

- I. Check your answer by multiplying your answer times the divisor and adding the remainder to this number

(NOTE: If you have solved the problem correctly, your check answer should be the same as your original number.)

EXAMPLE:
$$\begin{array}{r} 98 \\ \times 34 \\ \hline 392 \\ 294 \\ \hline 3332 \\ + 15 \\ \hline 3347 \end{array}$$

Answer
Divisor
Remainder
Check Answer (Same as original number)

INFORMATION SHEET

VIII. Types of fractions

- A. Proper — Top number of fraction (numerator) is smaller than bottom number of fraction (denominator)

EXAMPLE: $\frac{7}{8}$ Numerator
Denominator

- B. Improper — Top number of fraction (numerator) is equal to or larger than bottom number of fraction (denominator)

EXAMPLES: $\frac{9}{8}$ $\frac{16}{16}$

- C. Mixed numbers — Contains a whole number and a proper fraction

EXAMPLES: $9\frac{1}{2}$, $17\frac{7}{8}$, $4\frac{3}{4}$

- IX. Reducing fractions to lowest terms — Divide the numerator and denominator by the largest whole number that will go into each evenly

EXAMPLE: Reduce $\frac{4}{16}$ to its lowest terms.

$$\frac{4}{16} = \frac{4 \div 4}{16 \div 4} = \frac{1}{4}$$

(NOTE: The fraction $\frac{1}{4}$ is reduced to its lowest term because the numerator [1] and the denominator [4] cannot be divided by the same number.)

- X. Converting mixed numbers to improper fractions

- A. Multiply the whole number by the denominator of the fraction

EXAMPLE: Convert $4\frac{3}{8}$ to an improper fraction.

$$8 \times 4 = 32$$

- B. Add your answer to the numerator

EXAMPLE: $32 + 3 = 35$

- C. Place this sum over the original denominator

EXAMPLE: $\frac{35}{8}$ Improper Fraction

INFORMATION SHEET

XI. Convert improper fractions to mixed numbers

A. Divide the numerator by the denominator

EXAMPLE: Convert $18/15$ to a mixed number.

$$\begin{array}{r} 01 \\ 15 \overline{)18} \\ \underline{15} \\ 3 \text{ Remainder} \end{array}$$

B. Place the remainder over the denominator

EXAMPLE: $\frac{3}{15}$ — Remainder
 — Denominator

C. Reduce this fraction if necessary

EXAMPLE: $\frac{3}{15} = \frac{3 \div 3}{15 \div 3} = \frac{1}{5}$

D. Add the reduced fraction to the whole number obtained by dividing the numerator by the denominator

EXAMPLE: $1 + \frac{1}{5} = 1 \frac{1}{5}$ Mixed Number

XII. Adding fractions

A. Like fractions

(NOTE: Like fractions are those having the same, or common, denominators.)

EXAMPLES: $1/4$ and $2/4$, $5/8$ and $5/8$, $1/16$ and $1/16$

1. Add the numerators
2. Place sum of numerators over common denominator
3. Convert to mixed numbers and reduce as required

EXAMPLE 1: Add $1/4$ and $2/4$.

$$\frac{1}{4} + \frac{2}{4} = \frac{1+2}{4} = \frac{3}{4}$$

EXAMPLE 2: Add $5/8$ and $5/8$.

$$\frac{5}{8} + \frac{5}{8} = \frac{5+5}{8} = \frac{10}{8} = 10 \div 8 = 1 \frac{2}{8} = 1 \frac{1}{4}$$

INFORMATION SHEET

EXAMPLE 3: Add $\frac{1}{16}$ and $\frac{3}{16}$.

$$\frac{1}{16} + \frac{3}{16} = \frac{1+3}{16} = \frac{4}{16} = \frac{4 \div 4}{16 \div 4} = \frac{1}{4}$$

B. Unlike fractions

EXAMPLES: $\frac{11}{12}$ and $\frac{3}{9}$, $\frac{1}{8}$ and $\frac{3}{4}$

1. Change to like fractions

- Find the lowest number into which each denominator can be divided evenly (lowest common denominator)
- Multiply the numerators and denominators of each fraction by the number of times its denominator can be divided into the lowest common denominator

EXAMPLE 1: Add $\frac{11}{12}$ and $\frac{3}{9}$.

36 is lowest number into which both 12 and 9 can be divided evenly.

$$36 \div 12 = 3$$

$$36 \div 9 = 4$$

$$\frac{11}{12} = \frac{11 \times 3}{12 \times 3} = \frac{33}{36}$$

$$\frac{3}{9} = \frac{3 \times 4}{9 \times 4} = \frac{12}{36}$$

EXAMPLE 2: Add $\frac{1}{8}$ and $\frac{3}{4}$.

8 is the lowest number into which both 8 and 4 can be divided evenly.

$$8 \div 8 = 1$$

$$8 \div 4 = 2$$

 $\frac{1}{8}$ remains as $\frac{1}{8}$ because 8 is the common denominator.

$$\frac{3}{4} = \frac{3 \times 2}{4 \times 2} = \frac{6}{8}$$

INFORMATION SHEET

2. Add as like fractions and reduce or convert to mixed numbers as required

EXAMPLE 1: Add $1\frac{1}{12}$ and $\frac{3}{9}$.

$$\frac{11}{12} = \frac{33}{36} \text{ and } \frac{3}{9} = \frac{12}{36}$$

$$\frac{33}{36} + \frac{12}{36} = \frac{33 + 12}{36} = \frac{45}{36} = \frac{5}{4} = 1\frac{1}{4}$$

EXAMPLE 2: Add $\frac{1}{8}$ and $\frac{3}{4}$.

$$\frac{1}{8} \text{ remains } \frac{1}{8} \text{ and } \frac{3}{4} = \frac{6}{8}$$

$$\frac{1}{8} + \frac{6}{8} = \frac{1 + 6}{8} = \frac{7}{8}$$

C. Mixed numbers

1. Add whole numbers
2. Add fractions, first finding common denominators if necessary, and reduce or convert to mixed numbers as necessary
3. Add the sums of steps 1 and 2

EXAMPLE 1: Add $3\frac{1}{8}$ and $7\frac{3}{8}$.

$$3 + 7 = 10 \text{ Add whole numbers.}$$

$$\frac{1}{8} + \frac{3}{8} = \frac{1 + 3}{8} = \frac{4}{8} = \frac{1}{2} \text{ Add fractions and reduce.}$$

$$10 + \frac{1}{2} = 10\frac{1}{2} \text{ Add the sums of steps 1 and 2.}$$

EXAMPLE 2: Add $4\frac{2}{3}$ and $1\frac{5}{6}$.

$$4 + 1 = 5 \text{ Add whole numbers.}$$

$$\frac{2}{3} + \frac{5}{6} = \frac{4}{6} + \frac{5}{6} \text{ Find common denominator.}$$

$$\frac{4}{6} + \frac{5}{6} = \frac{9}{6} = 1\frac{3}{6} = 1\frac{1}{2} \text{ Add fractions, convert to mixed number, and reduce.}$$

$$5 + 1\frac{1}{2} = 6\frac{1}{2} \text{ Add sums of steps 1 and 2.}$$

INFORMATION SHEET

XIII. Subtracting fractions

A. Like fractions

1. Subtract smaller numerator from larger numerator

EXAMPLE: Subtract $\frac{1}{16}$ from $\frac{7}{16}$.

$$7 - 1 = 6$$

2. Place subtraction answer over common denominator

EXAMPLE: $\frac{6}{16}$

3. Reduce to lowest terms as required

EXAMPLE: $\frac{6}{16} = \frac{3}{8}$

B. Unlike fractions

1. Change to like fractions

EXAMPLE: Subtract $\frac{1}{2}$ from $\frac{3}{4}$.

$\frac{3}{4}$ remains the same because 4 is the common denominator.

$$\frac{1}{2} = \frac{1 \times 2}{2 \times 2} = \frac{2}{4}$$

2. Subtract as for like fractions

EXAMPLE: $\frac{3}{4} - \frac{2}{4} = \frac{3-2}{4} = \frac{1}{4}$

3. Reduce to lowest terms as required

C. Mixed numbers

1. Convert mixed numbers to like fractions

EXAMPLE: Subtract $3\frac{1}{2}$ from $5\frac{1}{8}$.

$$5\frac{1}{8} - 3\frac{1}{2} = 5\frac{1}{8} - 3\frac{4}{8}$$

2. Borrow a one from the original whole number if needed, convert the one to a like fraction, and add it to the smaller fraction

INFORMATION SHEET

(NOTE: This step is needed only if the like fraction in the original number is smaller than the like fraction in the subtracted number.)

EXAMPLE: $5\frac{1}{8} - 3\frac{4}{8} = (4\frac{8}{8} + \frac{1}{8}) - 3\frac{4}{8} = 4\frac{9}{8} - 3\frac{4}{8}$

3. Subtract whole number from whole number and like fraction from like fraction

EXAMPLE: $4\frac{9}{8} - 3\frac{4}{8} = 1\frac{5}{8}$

XIV. Multiplying fractions

- Convert any mixed numbers to improper fractions
- Multiply numerators by numerators and denominators by denominators
- Write the product of the numerators over the product of the denominators
- Convert improper fractions to mixed numbers and reduce as required

EXAMPLE 1: Multiply $\frac{1}{2}$ by $\frac{3}{4}$.

$$\frac{1}{2} \times \frac{3}{4} = \frac{1 \times 3}{2 \times 4} = \frac{3}{8}$$

EXAMPLE 2: Multiply $1\frac{1}{4}$ by $\frac{1}{2}$.

$$1\frac{1}{4} = \frac{5}{4} \text{ Convert to improper fraction.}$$

$$\frac{5}{4} \times \frac{1}{2} = \frac{5 \times 1}{4 \times 2} = \frac{5}{8}$$

XV. Dividing fractions

- Convert any mixed numbers to improper fractions

EXAMPLE: Divide $1\frac{3}{4}$ by $\frac{2}{3}$.

$$1\frac{3}{4} = \frac{7}{4} \text{ Convert to improper fraction.}$$

INFORMATION SHEET

B. Invert the divisor and multiply

EXAMPLE: $\frac{7}{4} \div \frac{2}{3} = \frac{7}{4} \times \frac{3}{2} = \frac{21}{8}$

(NOTE: If the divisor is a whole number, place it over 1 and invert.)

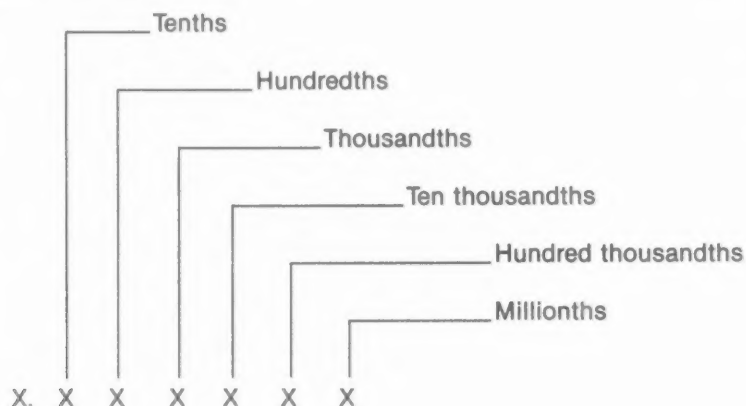
EXAMPLE: Divide $4\frac{3}{4}$ by 3.

$$\frac{19}{4} \div \frac{3}{1} = \frac{19}{4} \times \frac{1}{3}$$

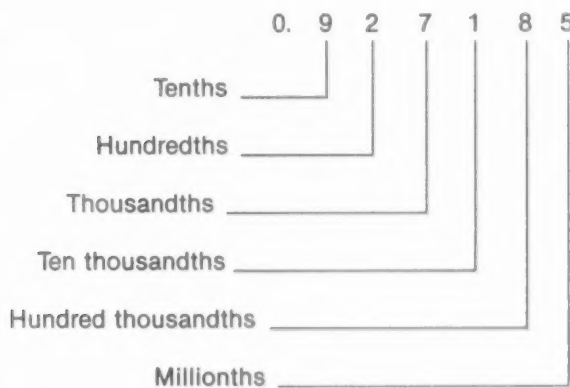
C. Convert improper fraction to a mixed number and reduce as required

EXAMPLE: $\frac{21}{8} = 2\frac{5}{8}$

XVI. Place values of decimal numbers



EXAMPLE:



(NOTE: The number in the example is read as nine hundred twenty-seven thousand, one hundred eighty-five millionths.)

INFORMATION SHEET

XVII. Adding decimal numbers

- A. Set up problem as for addition of whole numbers, aligning decimal points directly under each other

(NOTE: Zeros may be added to ensure that units line up under units, tens under tens, and so on. Whole numbers have an understood decimal point to the right of the units digit: 7 is 7., 75 is 75., and 754 is 754.)

EXAMPLE: Add 0.857, 2.1, 753, and 370.057.

$$\begin{array}{r}
 0.857 \\
 2.1 \\
 753 \\
 + 370.057 \\
 \hline
 \end{array}
 \quad \text{or} \quad
 \begin{array}{r}
 000.857 \\
 002.100 \\
 753.000 \\
 + 370.057 \\
 \hline
 \end{array}$$

- B. Add each column of numbers as for whole numbers
- C. Locate the decimal point in the answer by placing it directly under the decimal points above

EXAMPLE:

$$\begin{array}{r}
 000.857 \\
 002.100 \\
 753.000 \\
 + 370.057 \\
 \hline
 1126.014
 \end{array}
 \quad \text{Answer}$$

XVIII. Subtracting decimal numbers

- A. Set up problem as for subtraction of whole numbers, aligning decimal points directly under each other

EXAMPLE: Subtract 1.397 from 8.120.

$$\begin{array}{r}
 8.120 \quad \text{Original Number} \\
 - 1.397 \quad \text{Subtracted Number} \\
 \hline
 \end{array}$$

- B. Subtract each column of numbers as for whole numbers
- C. Locate the decimal point in the answer by placing it directly under the decimal points above

INFORMATION SHEET

- D. Check your subtraction by adding your answer to the subtracted number

(NOTE: If you have solved the problem correctly, your check answer should be the same as the original number.)

EXAMPLE:	8.120	Original Number
	<u>- 1.397</u>	Subtracted Number
	<u>+ 6.723</u>	Answer (Difference)
	8.120	Check Answer

XIX. Multiplying decimal numbers

- A. Set up problem and multiply as for multiplication of whole numbers

(NOTE: Do *not* align the decimal points in columns when setting up multiplication problems for decimal numbers.)

EXAMPLE: Multiply 27.935 by 7.07.

27.935	Original Number
<u>x 7.07</u>	Multiplier
195545	
<u>1955450</u>	
19750045	

- B. Add the number of decimal places to the right of the decimal points in the multiplier and original number

EXAMPLE:	27.935	3	Decimal Places
	<u>x 7.07</u>	<u>+2</u>	Decimal Places
		5	Total Decimal Places

- C. Locate decimal point in answer by beginning at far right digit and counting off as many places to the left as the total decimal places found in step B

EXAMPLE:	27.935	
	<u>x 7.07</u>	
	195545	
	<u>1955450</u>	
	197.50045	5 Decimal Places

XX. Dividing decimal numbers

- A. Set up problem as for division of whole numbers

EXAMPLE: Divide 0.25 by 0.005.

Divisor	0.005	<u>0.25</u>	Original Number
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INFORMATION SHEET

- B. Move the decimal point in the divisor to the right of the far right digit in the divisor

EXAMPLE: $0.005 \overline{)0.25}$

- C. Move the decimal point in the original number to the right by the same number of decimal places that you moved the decimal point in the divisor, adding zeros to the original number if necessary

EXAMPLE: $0.005 \overline{)0.250}$

(NOTE: If you are dividing a decimal number into a whole number, remember that whole numbers have an understood decimal point to the right of the units digit.)

EXAMPLE: $0.03 \overline{)9}$ becomes $0.03 \overline{)9.00}$

- D. Place a decimal point in the answer space directly above the repositioned decimal point in the original number

EXAMPLE: $0.005 \overline{)0.250}$

- E. Divide as for whole numbers

EXAMPLE:
$$\begin{array}{r} 50. \\ 0005 \overline{)0250} \\ \underline{025} \\ 00 \end{array}$$

- F. Check your division by multiplying the original divisor (before decimal point was moved) by your answer and adding any remainder to this number

(NOTE: If you have solved the problem correctly, your check answer should be the same as the original number.)

EXAMPLE:
$$\begin{array}{r} 0.005 \\ \times 50 \\ \hline 0.250 \end{array}$$

Divisor
Answer
Check Answer (Same as original number)

INFORMATION SHEET

XXI. Converting fractions to decimals and percentages

A. Fractions to decimals — Divide the numerator by the denominator

EXAMPLE: Convert $\frac{5}{8}$ to a decimal.

$\frac{5}{8}$	Numerator	$\frac{0.625}{8 \overline{)5.000}}$
	Denominator	$\begin{array}{r} 48 \\ \underline{20} \\ 16 \\ \underline{40} \\ 40 \\ \underline{0} \end{array}$

B. Fractions to percentages

(NOTE: Percent means that a number is a fraction of 100.)

1. Convert the fractions to decimals by dividing numerator by denominator
2. Move the decimal point in the answer two places to the right
3. Place the percent symbol after the number

EXAMPLE: Convert $\frac{7}{33}$ to a percentage.

$\frac{7}{33}$	Numerator	$\frac{0.2121}{33 \overline{)7.0000}} = 21.21\%$
	Denominator	$\begin{array}{r} 66 \\ \underline{40} \\ 33 \\ \underline{70} \\ 66 \\ \underline{40} \\ 33 \\ \underline{7} \end{array}$

INFORMATION SHEET

XXII. Decimal and fractional equivalents

	$\frac{1}{64}$	.015625
$\frac{1}{32}$	$\frac{3}{64}$	.03125
	$\frac{5}{64}$	.046875
$\frac{1}{16}$	$\frac{7}{64}$	.0625
	$\frac{9}{64}$	.078125
$\frac{3}{32}$	$\frac{11}{64}$	.09375
	$\frac{13}{64}$	.109375
$\frac{1}{8}$	$\frac{15}{64}$	.125
	$\frac{17}{64}$	.140625
$\frac{5}{32}$	$\frac{19}{64}$	.15625
	$\frac{21}{64}$	.171875
$\frac{3}{16}$	$\frac{23}{64}$	.1875
	$\frac{25}{64}$	.203125
$\frac{7}{32}$	$\frac{27}{64}$	.21875
	$\frac{29}{64}$	.234375
$\frac{1}{4}$	$\frac{31}{64}$	.25
	$\frac{33}{64}$	.265625
$\frac{9}{32}$	$\frac{35}{64}$	.28125
	$\frac{37}{64}$	.296875
$\frac{5}{16}$	$\frac{39}{64}$	.3125
	$\frac{41}{64}$	.328125
$\frac{11}{32}$	$\frac{43}{64}$	.34375
	$\frac{45}{64}$	.359375
$\frac{3}{8}$	$\frac{47}{64}$	.375
	$\frac{49}{64}$	.390625
$\frac{13}{32}$	$\frac{51}{64}$	.40625
	$\frac{53}{64}$	.421875
$\frac{7}{16}$	$\frac{55}{64}$	.4375
	$\frac{57}{64}$	.453125
$\frac{15}{32}$	$\frac{59}{64}$	.46875
	$\frac{61}{64}$	.484375
$\frac{1}{2}$	$\frac{63}{64}$	.5

	$\frac{33}{64}$	.515625
$\frac{17}{32}$	$\frac{35}{64}$	.53125
	$\frac{37}{64}$	.546875
$\frac{9}{16}$	$\frac{39}{64}$	.5625
	$\frac{41}{64}$	.578125
$\frac{19}{32}$	$\frac{43}{64}$	.59375
	$\frac{45}{64}$	.609375
$\frac{5}{8}$	$\frac{47}{64}$	.625
	$\frac{49}{64}$	.640625
$\frac{21}{32}$	$\frac{51}{64}$	.65625
	$\frac{53}{64}$	.671875
$\frac{11}{16}$	$\frac{55}{64}$	.6875
	$\frac{57}{64}$	.703125
$\frac{23}{32}$	$\frac{59}{64}$	.71875
	$\frac{61}{64}$	.734375
$\frac{3}{4}$	$\frac{63}{64}$	.75
	$\frac{65}{64}$	.765625
$\frac{25}{32}$	$\frac{67}{64}$	.78125
	$\frac{69}{64}$	.796875
$\frac{13}{16}$	$\frac{71}{64}$	.8125
	$\frac{73}{64}$	.828125
$\frac{27}{32}$	$\frac{75}{64}$	.84375
	$\frac{77}{64}$	.859375
$\frac{7}{8}$	$\frac{79}{64}$	.875
	$\frac{81}{64}$	.890625
$\frac{29}{32}$	$\frac{83}{64}$	.90625
	$\frac{85}{64}$	.921875
$\frac{15}{16}$	$\frac{87}{64}$	.9375
	$\frac{89}{64}$	.953125
$\frac{31}{32}$	$\frac{91}{64}$	.96875
	$\frac{93}{64}$	.984375
$\frac{1}{1}$	$\frac{95}{64}$	.1

INFORMATION SHEET

XXIII. Converting percentages to fractions and decimal numbers

A. Percentages to fractions

1. Drop the percent symbol
2. Place the number over 100
3. Reduce to lowest terms if necessary

EXAMPLE: Convert 38% to a fraction.

$$\begin{aligned}
 38\% &= 38 \\
 &= \frac{38}{100} \\
 &= \frac{19}{50}
 \end{aligned}$$

B. Percentages to decimals

1. Drop the percent symbol
2. Move decimal point two places to left

EXAMPLE: Convert 74% to a decimal.

$$\begin{aligned}
 74\% &= 74 \\
 &= 0.74
 \end{aligned}$$

XXIV. Solving percentage problems

(NOTE: Percentage problems may involve solving for the percent ["16 is what percent of 80?"], the part ["What number is 20% of 80?"], or the whole ["16 is 20% of what number?"].)

A. Write the unknown as "X"

EXAMPLE: 16 is what percent of 80?

16 is X percent of 80.

(NOTE: The unknown may be the percent, the part, or the whole.)

B. Write the percent (known or unknown) as a fraction with a denominator of 100

EXAMPLE: 16 is $\frac{X}{100}$ percent of 80.

INFORMATION SHEET

- C. Write the part and the whole as a fraction, writing the part as the numerator and the whole as the denominator

EXAMPLE: $\frac{16}{80}$ Part
Whole

- D. Set up the equation by writing the two fractions with an equal sign between them

EXAMPLE: $\frac{X}{100} = \frac{16}{80}$

- E. Solve the equation by multiplying the numerator of each fraction by the denominator of the other

(NOTE: This process is known as *cross multiplying*.)

EXAMPLE: $\frac{X}{100} = \frac{16}{80}$

$$80X = 1600$$

- F. Divide each side of the equation by the multiplier of X

EXAMPLE: $80X = 1600$

$$X = 20\%$$

$$16 \text{ is } 20\% \text{ of } 80.$$

- XXV. Solving ratio and proportion problems — To increase or decrease proportionally, multiply or divide each number in the ratio by the same number

(NOTE: Ratio indicates parts of material per mix; proportion indicates that the ratio is the same but the quantity may differ.)

EXAMPLE 1: You want to find half of the ratio 1:1:3.

Divide each number in the ratio by 2 to get 0.5:0.5:1.5.

EXAMPLE 2: You need three times the ratio 1:1:3.

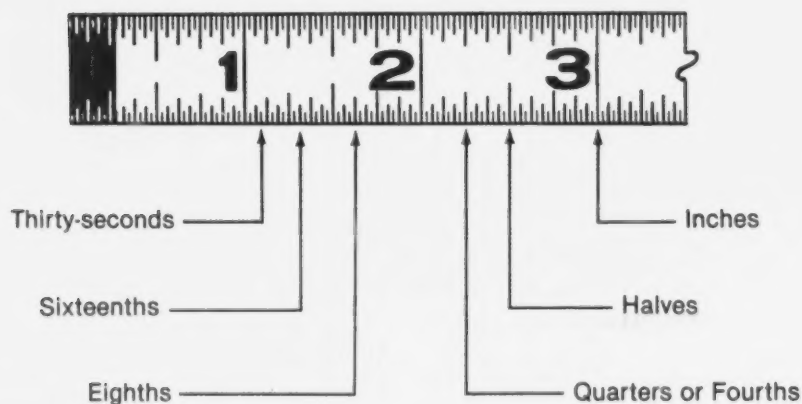
Multiply each number in the ratio by 3 to get 3:3:9.

INFORMATION SHEET

XXVI. Graduations on a rule (Figure 3)

(NOTE: Some rules will not have all of the graduations shown in Figure 3.)

FIGURE 3



(NOTE: Thirty-two 32nds equal 1 inch. Sixteen 16ths equal 1 inch. Eight 8ths equal 1 inch. Four 4ths equal 1 inch. Two halves equal 1 inch. Twelve inches equal 1 foot.)

XXVII. Reading a rule to the nearest fraction of an inch

(NOTE: All rules are read similarly. However, some rules are graduated with more divisions per inch than others, and some rules may have special markings for specific purposes.)

- A. Align the end of the rule with one reference point
- B. Determine the number of whole units between end of rule and second reference point
- C. Determine the number of fractional units between last whole unit and second reference point

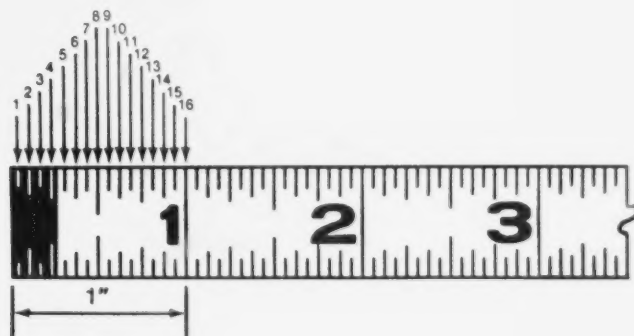
INFORMATION SHEET

1. Determine number of graduations per inch (Figure 4)

(NOTE: At first you may have to count the number of divisions in an inch. However, with some practice, you will be able to recognize the divisions on sight and will eventually be able to determine fractional units just by looking at the rule.)

EXAMPLE:

FIGURE 4



2. Determine the fractional part of an inch by counting the number of divisions between last inch and second reference point
3. Reduce the fraction if possible (Figure 5)

EXAMPLE:

FIGURE 5



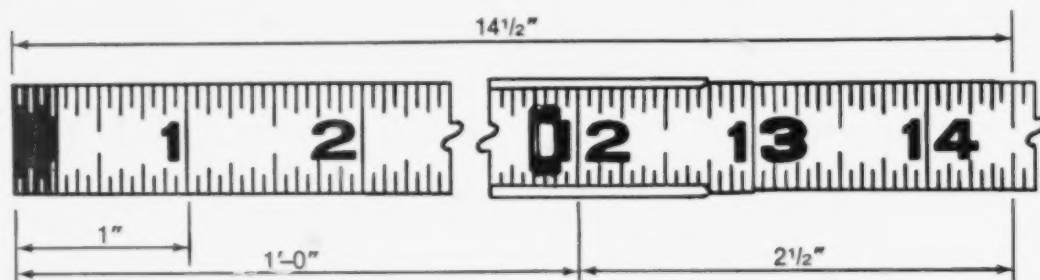
(NOTE: In the example above, the rule is divided into sixteenths. There are ten divisions between the last inch mark—3 inches—and the reference point. The $\frac{10}{16}$ can be reduced to $\frac{5}{8}$.)

INFORMATION SHEET

- D. Determine the reading by adding fractional units to whole units and converting inches to feet or feet to inches if necessary (Figure 6)

EXAMPLE: The rule below shows a measurement of $1' - 2\frac{1}{2}"$ or $14\frac{1}{2}"$.

FIGURE 6



MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #1 — ADD WHOLE NUMBERS

NAME _____ SCORE _____

Like most people, you probably use addition every day. For example, today you probably added coins together to pay for sodas and snacks. Every time you add, you use basic addition facts. The following exercises will form part of your auto-body math background and serve as a basis for completing other exercises and problems.

EXAMPLES:

$\begin{array}{r} 5 \\ + 10 \\ \hline 15 \end{array}$	$\begin{array}{r} 1 \leftarrow \text{Carried Digit} \\ 67 \\ + 25 \\ \hline 92 \end{array}$	$\begin{array}{r} 11 \leftarrow \text{Carried Digits} \\ 539 \\ 333 \\ + 432 \\ \hline 1304 \end{array}$
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PART I

Solve each of the following addition problems. Refer to Information Sheet, Section IV if necessary, and show your work.

A. $\begin{array}{r} 2 \\ + 9 \\ \hline \end{array}$	B. $\begin{array}{r} 8 \\ + 8 \\ \hline \end{array}$	C. $\begin{array}{r} 7 \\ + 6 \\ \hline \end{array}$	D. $\begin{array}{r} 15 \\ + 8 \\ \hline \end{array}$	E. $\begin{array}{r} 81 \\ + 27 \\ \hline \end{array}$
F. $\begin{array}{r} 7 \\ 38 \\ + 43 \\ \hline \end{array}$	G. $\begin{array}{r} 55 \\ 88 \\ + 99 \\ \hline \end{array}$	H. $\begin{array}{r} 341 \\ 428 \\ + 769 \\ \hline \end{array}$	I. $\begin{array}{r} 472 \\ 564 \\ + 881 \\ \hline \end{array}$	J. $\begin{array}{r} 9876 \\ 5432 \\ + 1122 \\ \hline \end{array}$

PART II

- A. If a technician used 330 lineal feet of tape on one job, 570 lineal feet on another, and 275 on another, how many lineal feet were used?

Total lineal feet = _____

- B. A technician ordered the following number of fasteners at different dates: 256, 62, 575, and 242. How many fasteners should she be billed for?

Total fasteners = _____

ASSIGNMENT SHEET #1

- C. If a technician paid \$480 for doors, \$13 for trim, \$81 for hardware, and \$35 for paint, what was the total cost of the materials?

Total cost of materials = \$_____

- D. If it takes 1135 square feet of sandpaper for one month, 1225 square feet for the second, 1220 square feet for the third, 1125 square feet for the fourth, and 7425 square feet for another shop, what would be the total square feet of sandpaper needed?

Total square feet = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #2 — SUBTRACT WHOLE NUMBERS

NAME _____

SCORE _____

Addition is the first fundamental operation in mathematics. Subtraction, the opposite of addition, is the process of finding the difference between two numbers. It is the second fundamental operation. You can check the accuracy of the answer obtained in a subtraction problem by simply adding the difference to the subtracted number. The sum of these two numbers will equal the original number if the answer is correct.

EXAMPLES:

12	Original Number
$\begin{array}{r} 12 \\ - 7 \\ \hline + 5 \\ \hline 12 \end{array}$	Subtracted Number
	Answer (Difference)
12	Check Answer (Same as original number)

57	Original Number
$\begin{array}{r} 57 \\ - 35 \\ \hline + 22 \\ \hline 57 \end{array}$	Subtracted Number
	Answer (Difference)
57	Check Answer

PART I

Solve each of the following subtraction problems. Check your answers by adding the difference to the subtracted number. Refer to Information Sheet, Section V if necessary, and show your work.

A. $\begin{array}{r} 9 \\ - 5 \\ \hline \end{array}$

B. $\begin{array}{r} 15 \\ - 8 \\ \hline \end{array}$

C. $\begin{array}{r} 75 \\ - 22 \\ \hline \end{array}$

D. $\begin{array}{r} 453 \\ - 47 \\ \hline \end{array}$

E. $\begin{array}{r} 742 \\ - 318 \\ \hline \end{array}$

F. $\begin{array}{r} 981 \\ - 698 \\ \hline \end{array}$

G. $\begin{array}{r} 1420 \\ - 245 \\ \hline \end{array}$

H. $\begin{array}{r} 3459 \\ - 1649 \\ \hline \end{array}$

I. $\begin{array}{r} 55722 \\ - 4272 \\ \hline \end{array}$

J. $\begin{array}{r} 98679 \\ - 8957 \\ \hline \end{array}$

PART II

- A. If a shop needs 172 shop towels and it has 46, how many more shop towels would the shop need for the job?

Number of shop towels = _____

ASSIGNMENT SHEET #2

- B. If you have 542 square feet of fiberglass and it takes 1702 square feet of fiberglass to complete the job, how many more square feet will you need?

Number of square feet needed = _____

- C. In the first year of operation a body shop handled 1219 jobs. During the second year the number of jobs increased to 2167. How many more jobs did the shop do in the second year?

Number of jobs = _____

- D. A custom body-shop owner estimated that it would take 450 hours to customize a van. During the first week, the crew spent 124 hours on the job. In the second week, 192 hours went into the project. How many hours of work are left if the original estimate is right?

Number of hours = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #3 — MULTIPLY WHOLE NUMBERS

NAME _____

SCORE _____

Multiplication is the third basic operation in mathematics. It is a shortcut method of adding. For example, if you correctly add twelve 12s, the result will be 144, the same as 12 multiplied by 12. Some multiplication problems involve carrying. You may write down the carried digits, or simply remember them. Use the method that works best for you.

When multiplying by numbers that contain two or more digits, you must be careful to align the partial products properly. Write the right-hand digit of each partial product directly below the multiplying digit. This causes the partial products to be properly aligned so that tens will be added to tens, hundreds to hundreds, and so on.

EXAMPLES:

$$\begin{array}{r} 8 \\ \times 7 \\ \hline 56 \end{array}$$

$$\begin{array}{r} 1 \leftarrow \text{Carried Digit} \\ 53 \\ \times 4 \\ \hline 212 \end{array}$$

$$\begin{array}{r} 11 \leftarrow \text{Carried Digits} \\ 756 \\ \times 312 \\ \hline 1512 \leftarrow \text{First Partial Product} \\ 756 \leftarrow \text{Second Partial Product} \\ 2268 \leftarrow \text{Third Partial Product} \\ \hline 235872 \leftarrow \text{Product} \end{array}$$

PART I

Solve each of the following multiplication problems. Refer to Information Sheet, Section VI if necessary, and show your work.

A.
$$\begin{array}{r} 6 \\ \times 7 \\ \hline \end{array}$$

B.
$$\begin{array}{r} 9 \\ \times 8 \\ \hline \end{array}$$

C.
$$\begin{array}{r} 54 \\ \times 6 \\ \hline \end{array}$$

D.
$$\begin{array}{r} 721 \\ \times 4 \\ \hline \end{array}$$

E.
$$\begin{array}{r} 1682 \\ \times 5 \\ \hline \end{array}$$

F.
$$\begin{array}{r} 78 \\ \times 26 \\ \hline \end{array}$$

G.
$$\begin{array}{r} 453 \\ \times 47 \\ \hline \end{array}$$

H.
$$\begin{array}{r} 314 \\ \times 527 \\ \hline \end{array}$$

I.
$$\begin{array}{r} 2143 \\ \times 235 \\ \hline \end{array}$$

J.
$$\begin{array}{r} 4123 \\ \times 1324 \\ \hline \end{array}$$

ASSIGNMENT SHEET #3

PART II

- A. A bolt of seat upholstery material contains 75 yards of material. How many yards of material are in six bolts?

Number of yards = _____

- B. If a technician can paint an average of 170 square feet of surface per hour, how many square feet could be painted in 48 hours?

Number of square feet = _____

- C. Six technicians mask an average of 950 lineal feet of surface per person per hour. What will be their average for 3 hours' work?

Average lineal feet = _____

- D. Figure the amount of time worked in 4 weeks by 12 technicians who work 30 hours each week.

Hours worked = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #4 — DIVIDE WHOLE NUMBERS

NAME _____

SCORE _____

Auto-body technicians use division in many aspects of their work. Trim, molding, upholstery material, paint, and many other materials come in predetermined sizes or volumes. By dividing the quantity needed or space allowed for such materials, the technician can determine the amount required. Division is also used to compute costs and expenses and in making estimates.

Division is the fourth and last basic operation in mathematics. Multiplication puts together—division takes apart. Division is the reverse of multiplication. Long division is the name used for division by numbers that cannot readily be used as simple dividers. Division answers are checked by multiplying the divisor by the answer and adding the remainder.

EXAMPLES:
$$\begin{array}{r} \text{Answer} \\ \text{Divisor } 3 \overline{)972} \\ \underline{9} \\ 7 \\ \underline{6} \\ 12 \\ \underline{12} \end{array}$$

$$\begin{array}{r} \text{0111 Answer} \\ 51 \overline{)5678} \\ \underline{51} \\ 57 \\ \underline{51} \\ 68 \\ \underline{51} \\ 17 \text{ Remainder} \end{array}$$

Check:
$$\begin{array}{r} \text{111 Answer} \\ \times 51 \text{ Divisor} \\ \hline 111 \\ 555 \\ \hline 5661 \\ + 17 \text{ Remainder} \\ \hline 5678 \text{ Original Number} \end{array}$$

PART I

Solve each of the following division problems. Check your answers by multiplying the divisor by the original number. Refer to Information Sheet, Section VII if necessary, and show your work.

A. $2 \overline{)8}$

B. $6 \overline{)48}$

C. $9 \overline{)819}$

D. $4 \overline{)1248}$

E. $13 \overline{)39}$

ASSIGNMENT SHEET #4

F. $66 \overline{)198}$

G. $84 \overline{)5212}$

H. $124 \overline{)345}$

I. $464 \overline{)829}$

J. $748 \overline{)2872}$

PART II

- A. A shop painted 1456 automobiles in one year. What was the average number of automobiles painted per week, using 52 as the number of weeks in a year?

Average number of automobiles painted per week = _____

- B. Amy Armbush has contracted to paint a fleet of trucks for a company. If Amy has to paint 37 trucks in four weeks, how many trucks will her shop have to paint per week?

Trucks painted per week = _____

- C. A technician masked 26 automobiles for painting. The project required 2535 lineal feet of masking tape. How much tape was required on the average per automobile?

Average amount of tape per automobile = _____

- D. John Picks is planning to build a new body shop. In calculating the ventilation required, he finds that all the air in the building must be changed every three minutes. How many fans will be required if each fan removes 1300 cubic feet of air per minute and the shop contains 15,600 cubic feet?

Number of fans needed = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #5 — WORK WITH FRACTIONS

NAME _____

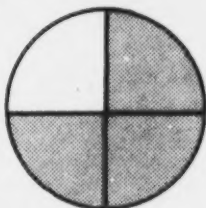
SCORE _____

Fractions are essential to the auto-body trade. Not only does the technician frequently use fractions for measurements, but much of the material used in the trade is sized by fractional units. For instance, tools, replacement parts, rivets, bolts, screws, fasteners, and trim may all be sized in fractional units. This frequent use of fractions in the trade makes it necessary for the good technician to understand thoroughly how to work with fractions.

When something is divided into parts that are all the same size, or of equal size, it is divided into fractional parts. For example, the circle below is divided into four fractional parts.



To talk about fractional parts, you use fractions. For example, one of the four parts of the circle below is unshaded, or $\frac{1}{4}$ of the circle is unshaded; three of the four parts of the circle are shaded, or $\frac{3}{4}$ of the circle is shaded.



In the fraction $\frac{3}{4}$, the 4 is called the denominator. It shows the number of equal parts into which the circle is divided. The 3 is called the numerator. It shows the number of parts that are used.

PART I

A. Fill in the blanks to identify the numerator and denominator of each of the following fractions. Refer to Information Sheet, Section VIII if necessary.

1. In the fraction $\frac{5}{8}$, the numerator is _____ and the denominator is _____.

2. In the fraction $\frac{7}{16}$, 7 is the _____ and 16 is the _____.

ASSIGNMENT SHEET #5

3. In the fraction $\frac{1}{4}$, what is the numerator? _____ denominator? _____

B. Write the fractions that fit the following statements.

_____ 1. A fraction with a denominator of 16 and a numerator of 10.

_____ 2. A fraction with a numerator of 16 and a denominator of 32.

C. A technician cuts a piece of sheet metal into 8 equal pieces and then uses 1 of the 8 pieces.

_____ 1. Which number represents the numerator?

_____ 2. Which number represents the denominator?

_____ 3. What fractional part of the sheet metal did the technician use?

PART II

A. Match the shaded portions of the following figures to the fractions they represent. Write the correct letters in the blanks.

_____ 1. $\frac{4}{8}$

_____ 2. $\frac{2}{2}$

_____ 3. $\frac{6}{16}$

_____ 4. $\frac{3}{8}$

_____ 5. $\frac{5}{8}$

_____ 6. $\frac{1}{2}$

_____ 7. $\frac{7}{16}$

_____ 8. $\frac{3}{4}$

_____ 9. $\frac{1}{4}$

_____ 10. $\frac{1}{8}$

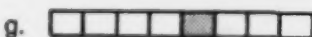
_____ 11. $\frac{7}{8}$

_____ 12. $\frac{2}{4}$

_____ 13. $\frac{2}{8}$

_____ 14. $\frac{13}{16}$

_____ 15. $\frac{6}{8}$



ASSIGNMENT SHEET #5

B. Draw a figure shaded to represent each of the following fractions.

EXAMPLE: $\frac{3}{4}$ 

1. $\frac{1}{2}$

6. $\frac{5}{16}$

2. $\frac{3}{4}$

7. $\frac{2}{8}$

3. $\frac{5}{8}$

8. $\frac{3}{16}$

4. $\frac{1}{4}$

9. $\frac{3}{8}$

5. $\frac{7}{8}$

10. $\frac{13}{16}$

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #6 — REDUCE FRACTIONS TO LOWEST TERMS

NAME _____ SCORE _____

Fractions are "reduced" to their lowest terms so that they are more readily understood or recognized. For example, $\frac{1}{2}$ is more easily recognized than $\frac{16}{32}$.

To reduce a fraction to its lowest terms, divide the numerator and the denominator by the largest whole number that will go into both evenly.

EXAMPLES: $\frac{9}{12} = \frac{9 \div 3}{12 \div 3} = \frac{3}{4}$ $\frac{12}{32} = \frac{12 \div 4}{32 \div 4} = \frac{3}{8}$

Reduce the following fractions to their lowest terms. Refer to Information Sheet, Section IX if necessary.

A. $\frac{4}{8} =$ _____

F. $\frac{9}{24} =$ _____

B. $\frac{8}{16} =$ _____

G. $\frac{16}{32} =$ _____

C. $\frac{2}{2} =$ _____

H. $\frac{2}{4} =$ _____

D. $\frac{4}{16} =$ _____

I. $\frac{9}{12} =$ _____

E. $\frac{12}{48} =$ _____

J. $\frac{50}{100} =$ _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #7 — CONVERT UNLIKE FRACTIONS TO LIKE FRACTIONS

NAME _____

SCORE _____

Fractions must have common denominators if they are to be added or subtracted. Fractions that have the same denominator are said to have a *common* denominator and to be *like fractions*. The easiest way to find a common denominator for two fractions is to multiply the numerator and the denominator of each fraction by the denominator of the other fraction.

EXAMPLE: Find a common denominator for the fractions $\frac{1}{4}$ and $\frac{3}{16}$ and convert to like fractions.

$$\frac{1}{4} = \frac{1 \times 16}{4 \times 16} = \frac{16}{64} \quad \text{and} \quad \frac{3}{16} = \frac{3 \times 4}{16 \times 4} = \frac{12}{64}$$

Because a common denominator is any denominator into which the denominators of both fractions will divide evenly, two fractions can have a number of common denominators. Although it is easy to find common denominators by multiplying the denominators by one another, this often leads to numbers that are awkward to work with. For that reason, fractions are usually added after the *lowest* common denominator has been found.

EXAMPLE: Common denominators for the fractions $\frac{1}{4}$ and $\frac{3}{16}$ include 16, 32, 48, 64, 80, and many more.

$\frac{4}{16}$ and $\frac{3}{16}$
 $\frac{8}{32}$ and $\frac{6}{32}$
 $\frac{12}{48}$ and $\frac{9}{48}$
 $\frac{16}{64}$ and $\frac{12}{64}$
 $\frac{20}{80}$ and $\frac{15}{80}$

The lowest common denominator is the lowest one into which the others can be divided evenly. To find the lowest common denominator, find any common denominator by the method shown above, and reduce it.

EXAMPLE: Convert the fractions $\frac{6}{15}$ and $\frac{3}{10}$ to like fractions with the lowest common denominator.

$$\frac{6}{15} = \frac{6 \times 10}{15 \times 10} = \frac{60}{150} = \frac{12}{30} \quad \text{and} \quad \frac{3}{10} = \frac{3 \times 15}{10 \times 15} = \frac{45}{150} = \frac{9}{30}$$

ASSIGNMENT SHEET #7

To change a fraction to its equivalent with a higher denominator, multiply the denominator of the given fraction by a number that will give the desired denominator; then multiply the numerator of the fraction by the same multiplier.

EXAMPLE: You want to find out how many eighths there are in $\frac{1}{2}$.

$$\frac{1}{2} \times 4 = \frac{?}{8} \quad \text{Multiply the denominator by 4 to give you the eighths denominator.}$$

$$\frac{1}{2} = \frac{?}{8} \quad \frac{1 \times 4}{2 \times 4} = \frac{4}{8} \quad \frac{1}{2} = \frac{4}{8}$$

To change a fraction to its equivalent with a lower denominator, divide both the denominator and the numerator by the same number.

EXAMPLE: You want to find out how many fourths there are in $\frac{12}{16}$.

$$\frac{12}{16} = \frac{?}{4} \quad \frac{12 \div 4}{16 \div 4} = \frac{3}{4} \quad \frac{12}{16} = \frac{3}{4}$$

PART I

Convert each of the fractions below to equivalent fractions for the denominator given.

A. $\frac{1}{2} = \frac{\quad}{8}$

E. $\frac{6}{8} = \frac{\quad}{4}$

I. $\frac{3}{4} = \frac{\quad}{8}$

B. $\frac{1}{4} = \frac{\quad}{32}$

F. $\frac{5}{8} = \frac{\quad}{32}$

J. $\frac{7}{8} = \frac{\quad}{32}$

C. $\frac{12}{16} = \frac{\quad}{4}$

G. $\frac{9}{16} = \frac{\quad}{32}$

K. $\frac{24}{32} = \frac{\quad}{4}$

D. $\frac{10}{32} = \frac{\quad}{16}$

H. $\frac{18}{32} = \frac{\quad}{16}$

L. $\frac{28}{64} = \frac{\quad}{16}$

PART II

Multiply the denominators in the following sets of fractions to convert them to like fractions.

A. $\frac{3}{8}$ and $\frac{1}{2} = \frac{\quad}{\quad}$ and $\frac{\quad}{\quad}$

B. $\frac{3}{4}$ and $\frac{9}{32} = \frac{\quad}{\quad}$ and $\frac{\quad}{\quad}$

ASSIGNMENT SHEET #7

C. $\frac{1}{16}$ and $\frac{5}{8} =$ _____ and _____

D. $\frac{1}{2}$ and $\frac{7}{16} =$ _____ and _____

E. $\frac{3}{4}$ and $\frac{9}{16}$ and $\frac{7}{32} =$ _____ and _____ and _____

PART III

Change the following sets of fractions to like fractions with the *lowest* common denominators.

A. $\frac{3}{10}$ and $\frac{1}{4} =$ _____ and _____

B. $\frac{2}{3}$ and $\frac{3}{16} =$ _____ and _____

C. $\frac{3}{4}$ and $\frac{9}{32} =$ _____ and _____

D. $\frac{1}{2}$ and $\frac{7}{16} =$ _____ and _____

E. $\frac{3}{4}$ and $\frac{5}{8}$ and $\frac{7}{10} =$ _____ and _____ and _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #8 — CONVERT FRACTIONS AND MIXED NUMBERS

NAME _____

SCORE _____

A fraction such as $\frac{3}{4}$ is called a *proper fraction* because its numerator (top number) is smaller than its denominator (bottom number). Some examples of proper fractions are $\frac{2}{3}$, $\frac{1}{5}$, and $\frac{7}{8}$.

When the numerator of a fraction is the same, or larger, than the denominator, the fraction is called an *improper fraction*. Some examples of improper fractions are $\frac{4}{4}$, $\frac{5}{3}$, $\frac{9}{4}$, and $\frac{10}{8}$.

Numbers such as $2\frac{1}{2}$, $5\frac{3}{4}$, and $6\frac{2}{5}$ are called *mixed numbers*. They are made up of a whole number and a proper fraction.

Complete the following exercises. Refer to Information Sheet, Sections VIII, X, and XI if necessary.

PART I

- A. Distinguish among the following fractions by writing a "P" in the blanks before a proper fraction, an "I" before an improper fraction, and an "M" in the blanks before a mixed number.

_____ 1. $\frac{1}{2}$

_____ 9. $\frac{4}{4}$

_____ 2. $3\frac{7}{8}$

_____ 10. $9\frac{3}{16}$

_____ 3. $\frac{16}{2}$

_____ 11. $5\frac{1}{2}$

_____ 4. $3\frac{1}{8}$

_____ 12. $\frac{9}{8}$

_____ 5. $\frac{1}{4}$

_____ 13. $\frac{9}{4}$

_____ 6. $\frac{1}{1}$

_____ 14. $\frac{1}{8}$

_____ 7. $\frac{7}{2}$

_____ 15. $16\frac{3}{4}$

_____ 8. $8\frac{1}{2}$

- B. Write a numerator over each of the following denominators to make proper fractions.

1. $\frac{\quad}{8}$

4. $\frac{\quad}{2}$

2. $\frac{\quad}{4}$

5. $\frac{\quad}{16}$

3. $\frac{\quad}{32}$

ASSIGNMENT SHEET #8

C. Write a numerator over each of the following denominators to make improper fractions.

1. $\frac{\quad}{2}$

2. $\frac{\quad}{4}$

3. $\frac{\quad}{16}$

4. $\frac{\quad}{8}$

5. $\frac{\quad}{4}$

PART II

A. Convert each of the following mixed numbers to improper fractions. Reduce to lowest terms when possible.

1. $3\frac{1}{4} = \underline{\hspace{2cm}}$

6. $5\frac{2}{4} = \underline{\hspace{2cm}}$

2. $4\frac{1}{2} = \underline{\hspace{2cm}}$

7. $4\frac{1}{4} = \underline{\hspace{2cm}}$

3. $7\frac{3}{4} = \underline{\hspace{2cm}}$

8. $8\frac{1}{2} = \underline{\hspace{2cm}}$

4. $8\frac{1}{2} = \underline{\hspace{2cm}}$

9. $9\frac{1}{4} = \underline{\hspace{2cm}}$

5. $6\frac{1}{8} = \underline{\hspace{2cm}}$

10. $16\frac{1}{2} = \underline{\hspace{2cm}}$

B. Convert each of the following improper fractions to mixed numbers. Reduce to lowest terms when possible.

1. $\frac{7}{4} = \underline{\hspace{2cm}}$

6. $\frac{11}{8} = \underline{\hspace{2cm}}$

2. $\frac{9}{2} = \underline{\hspace{2cm}}$

7. $\frac{75}{32} = \underline{\hspace{2cm}}$

3. $\frac{6}{4} = \underline{\hspace{2cm}}$

8. $\frac{5}{2} = \underline{\hspace{2cm}}$

4. $\frac{15}{8} = \underline{\hspace{2cm}}$

9. $\frac{15}{4} = \underline{\hspace{2cm}}$

5. $\frac{19}{16} = \underline{\hspace{2cm}}$

10. $\frac{33}{16} = \underline{\hspace{2cm}}$

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #9 — ADD FRACTIONS

NAME _____ SCORE _____

One of the most common calculations done by a technician is the addition of fractions. For example, side molding is seldom installed in lengths of even feet or inches. Often the length of the molding for each panel can only be determined by adding several dimensions, any of which may include a fraction. For accurate installation, the lengths must be figured correctly.

To add common fractions, change to equivalent fractions with lowest common denominators. Add the new numerators and place this sum over the lowest common denominator. If the result is an improper fraction, change it to a mixed number and reduce to lowest terms.

EXAMPLE: $\frac{2}{3} + \frac{3}{4} = \frac{8}{12} + \frac{9}{12} = \frac{17}{12} = 1 \frac{5}{12}$

Find common denominators and add the following fractions. Reduce to lowest terms. Refer to Information Sheet, Section XII if necessary.

A. $\frac{1}{4} + \frac{2}{8} =$ _____

E. $\frac{3}{4} + \frac{5}{32} =$ _____

B. $\frac{4}{16} + \frac{3}{4} =$ _____

F. $\frac{7}{8} + \frac{5}{16} =$ _____

C. $\frac{5}{8} + \frac{3}{32} =$ _____

G. $\frac{9}{16} + \frac{3}{4} =$ _____

D. $\frac{9}{16} + \frac{5}{8} =$ _____

H. $\frac{4}{4} + \frac{25}{32} =$ _____

ASSIGNMENT SHEET #9

- I. A paint for refinishing requires mixing a paint and a reducer. How many gallons of paint will be produced if you must mix 1 pint of reducer with 2 quarts of paint?

(NOTE: There are 8 pints in a gallon. There are 4 quarts in a gallon.)

Gallons of paint = _____

- J. A technician puts both carpet and pad in an automobile. What is the total thickness if the carpet is $\frac{7}{16}$ inch thick and the pad is $2\frac{1}{32}$ inch thick?

Total thickness = _____

- K. What is the total clearance of a door with $\frac{1}{8}$ -inch top clearance, $\frac{1}{2}$ -inch bottom clearance, and $\frac{9}{16}$ -inch total side clearance?

Total clearance = _____

- L. A technician is fitting self-adhesive side trim. What is the total amount of trim removed if the technician removes $\frac{3}{8}$ inch at the front fender, $\frac{1}{2}$ inch at the door, and $3\frac{1}{2}$ inches at the rear fender?

Amount of trim removed = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #10 — SUBTRACT FRACTIONS

NAME _____

SCORE _____

Just as technicians must frequently add fractions, they must also subtract fractions. Although unibody repair dimensions may look nice and even, the actual adjustments lead to many fractional measurements. Subtraction of fractions is helpful in figuring such installation dimensions.

To subtract common fractions, change to equivalent fractions with common denominators. Find the difference between the numerators of the equivalent fractions. Place the difference over the common denominator and, if necessary, reduce the answer to lowest terms.

EXAMPLE: $\frac{2}{3} - \frac{1}{4}$ becomes $\frac{8}{12} - \frac{3}{12} = \frac{5}{12}$

Subtract each of the common fractions given below. Reduce to lowest terms. Refer to Information Sheet, Section XIII if necessary.

A. $\frac{3}{4} - \frac{3}{16} =$ _____

F. $\frac{15}{16} - \frac{3}{8} =$ _____

B. $\frac{7}{8} - \frac{1}{4} =$ _____

G. $\frac{1}{2} - \frac{7}{16} =$ _____

C. $\frac{30}{32} - \frac{3}{4} =$ _____

H. $\frac{3}{4} - \frac{3}{8} =$ _____

D. $\frac{25}{32} - \frac{5}{8} =$ _____

I. $\frac{13}{16} - \frac{9}{32} =$ _____

E. $\frac{7}{8} - \frac{2}{16} =$ _____

J. $\frac{7}{8} - \frac{6}{16} =$ _____

ASSIGNMENT SHEET #10

- K. The original width of a pillar is $3\frac{3}{4}$ inches. The damaged pillar measures $3\frac{1}{4}$ inches. How much difference is there between the original width and the damaged width?

Difference in width = _____

- L. The directions for installing sheet-metal screws state that the technician must first drill a hole $\frac{1}{32}$ inch smaller than the diameter of the screw. What diameter hole must be drilled if a technician uses screws with an $\frac{1}{8}$ -inch diameter?

Hole diameter = _____

- M. What is the difference in thickness between a $\frac{1}{2}$ -inch door gasket and $\frac{5}{8}$ -inch door gasket?

Difference in thickness = _____

- N. A saw blade removes $\frac{1}{64}$ inch of sheet metal for each cut. A length of sheet metal $47\frac{5}{8}$ inches long is cut in two. If one piece is $24\frac{1}{2}$ inches long, how long is the other piece?

Length = _____

- O. A bolt is $3\frac{1}{4}$ inches long, not counting the head. If the bumper bracket is $1\frac{1}{2}$ -inches thick, how much of the bolt will extend beyond the bracket?

Length of extended part of bolt = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #11 — MULTIPLY FRACTIONS

NAME _____

SCORE _____

Multiplying with fractions is often a shortcut for adding fractions; and because technicians often add similar fractions, they can multiply to save time. A good technician quickly learns to appreciate the convenience of being able to multiply fractions when possible.

To multiply fractions, multiply the numerators and denominators separately. Write the product of the numerator over the product of the denominator and reduce to lowest terms.

EXAMPLE: $\frac{2}{3} \times \frac{3}{4}$ becomes $\frac{2 \times 3}{3 \times 4} = \frac{6}{12} = \frac{1}{2}$

Multiply the following fractions. Convert mixed fractions where needed and reduce answers to lowest terms. Refer to Information Sheet, Section XIV if necessary.

A. $\frac{1}{2} \times \frac{3}{4} =$ _____

B. $\frac{3}{8} \times \frac{5}{16} =$ _____

C. $1\frac{1}{2} \times 2\frac{1}{4} =$ _____

D. $\frac{1}{2} \times 6\frac{1}{2} =$ _____

E. $\frac{7}{8} \times \frac{2}{3} =$ _____

F. $1\frac{1}{3} \times 2\frac{1}{4} \times \frac{1}{2} =$ _____

G. $\frac{1}{4} \times \frac{1}{3} \times \frac{1}{2} =$ _____

H. $2\frac{3}{4} \times 6\frac{1}{8} =$ _____

ASSIGNMENT SHEET #11

- I. A certain paint requires mixing $\frac{3}{4}$ gallon base and $\frac{1}{4}$ gallon hardener to make a gallon of finish. How much base should a technician use if she needs to mix only $\frac{1}{3}$ gallon of finish?

Amount of base = _____

- J. There are 296 fasteners per pound. How many fasteners are there in $\frac{1}{4}$ pound?

Number of fasteners = _____

- K. After completing three painting jobs, a technician has $8\frac{2}{3}$ gallons of paint left in three different colors. If one-half of the paint is yellow, how many gallons of yellow paint are there?

Number of gallons of yellow paint = _____

- L. A technician wants to drill a hole in the fender for an antenna half way across the $1\frac{3}{4}$ -inch fender edge. Where must the hole be drilled?

Hole location = _____ from each side of edge

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #12 — DIVIDE FRACTIONS

NAME _____

SCORE _____

Auto-body technicians divide fractions in many aspects of their work. Painting, and installing trim, molding, stripes, or masking are examples of auto-body jobs that may require the technician to divide fractions in order to determine amounts or lengths needed.

Except for inverting the divisor, dividing fractions follows the same process as that for multiplying fractions. To divide fractions, convert any mixed numbers to improper fractions, invert the divisor, and multiply. Convert the improper fraction to a mixed number and reduce as required.

EXAMPLE: $3\frac{7}{8} \div 1\frac{1}{2} = \frac{31}{8} \div \frac{3}{2}$

$$= \frac{31}{8} \times \frac{2}{3}$$

$$= \frac{62}{24} \text{ reduced to } \frac{31}{12}$$

$$= 31 \div 12$$

$$= 2\frac{7}{12}$$

Divide the following fractions. Refer to the example above and to Information Sheet, Section XV if necessary.

A. $\frac{3}{4} \div \frac{1}{2} = \underline{\hspace{2cm}}$

B. $\frac{3}{8} \div \frac{5}{16} = \underline{\hspace{2cm}}$

C. $2\frac{1}{4} \div 1\frac{1}{2} = \underline{\hspace{2cm}}$

D. $1\frac{1}{2} \div \frac{3}{5} = \underline{\hspace{2cm}}$

E. $\frac{7}{8} \div \frac{2}{3} = \underline{\hspace{2cm}}$

F. $5\frac{5}{8} \div 2\frac{1}{2} = \underline{\hspace{2cm}}$

G. $2\frac{3}{4} \div \frac{3}{16} = \underline{\hspace{2cm}}$

H. $6\frac{1}{4} \div \frac{5}{32} = \underline{\hspace{2cm}}$

ASSIGNMENT SHEET #12

- I. A technician is applying racing stripes to six automobiles. She has one roll of striping tape $48\frac{1}{2}$ feet long. How many feet of striping tape can the technician use on each automobile?

Number of feet = _____

- J. A technician has $15\frac{1}{5}$ gallons of paint with which to paint eight automobiles. How many gallons of paint can he use on each automobile?

Number of gallons = _____

- K. In the shop storeroom are $3\frac{1}{2}$ boxes of steel wool with six pads in each box. The auto-body technician needs four pads per automobile. On how many automobiles can the technician use steel wool?

Number of automobiles = _____

- L. On hand are $142\frac{3}{8}$ inches of a certain gauge electrical wire. Each circuit requires $16\frac{1}{2}$ inches of this gauge wire. How many circuits can be wired?

Number of circuits = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #13 — ADD DECIMAL NUMBERS

NAME _____

SCORE _____

A technician often needs to calculate the costs of repairing an automobile. Such costs are figured in dollars and cents. But cents are only decimal parts of a dollar, and every time technicians or anyone else totals the cost of a purchase, they are adding decimals.

You can add decimals just as you add whole numbers. You must be careful, though, to keep all decimal points aligned.

Add each column of numbers, carrying when necessary. Place a decimal point in the answer directly under the decimal points above. Refer to Information Sheet, Section XVII if necessary.

EXAMPLES:

$$\begin{array}{r} 0.26 \\ + 0.168 \\ \hline 0.428 \end{array}$$

$$\begin{array}{r} \$4.60 \\ + \quad .40 \\ \hline \$5.00 \end{array}$$

A.
$$\begin{array}{r} 0.024 \\ + 0.165 \\ \hline \end{array}$$

B.
$$\begin{array}{r} 0.873 \\ + 0.199 \\ \hline \end{array}$$

C.
$$\begin{array}{r} \$4.60 \\ + \quad 4.62 \\ \hline \end{array}$$

D.
$$\begin{array}{r} 0.0003 \\ + 0.0099 \\ \hline \end{array}$$

E.
$$\begin{array}{r} \$62.14 \\ + \quad 8.87 \\ \hline \end{array}$$

F.
$$\begin{array}{r} \$34.87 \\ + \quad 96.45 \\ \hline \end{array}$$

G.
$$\begin{array}{r} 195.7 \\ 83. \\ + \quad 9.006 \\ \hline \end{array}$$

H.
$$\begin{array}{r} 0.0131 \\ 0.1840 \\ + 0.2229 \\ \hline \end{array}$$

I.
$$\begin{array}{r} 4.612 \\ 0.958 \\ + 0.885 \\ \hline \end{array}$$

J.
$$\begin{array}{r} 4937.23 \\ 4980.47 \\ 10234.97 \\ + 9872.21 \\ \hline \end{array}$$

K.
$$\begin{array}{r} 15.125 \\ 4.625 \\ 20.125 \\ + 16.125 \\ \hline \end{array}$$

L.
$$\begin{array}{r} 0.52802 \\ 0.34007 \\ 0.00321 \\ + 0.00009 \\ \hline \end{array}$$

ASSIGNMENT SHEET #13

- M. A technician bought some materials and spent \$141.72 for molding, \$16.81 for fasteners, and \$6.27 for screws. What was the total cost of the materials?

Total cost = _____

- N. A technician worked four days on a certain project. She worked 6.8 hours Monday, 7.4 hours Tuesday, 9.3 hours Wednesday, and 4.4 hours Thursday. How many total hours did she work on the project?

Total hours worked = _____

- O. How much was spent on tools if a technician bought the tools below at the prices listed?

Sander	\$95.88
Screwdriver	\$9.95
Drill bit	39¢
Shop hammer	\$6.49
Body hammer	\$10

Total cost = _____

- P. For tax purposes, a technician must keep track of mileage driven in the line of work. During the past quarter, he drove 386.4 miles the first month, 519 miles the second month, and 461.2 miles the third month. What was his total mileage for the quarter?

Total mileage = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #14 — SUBTRACT DECIMAL NUMBERS

NAME _____ SCORE _____

Decimals are a part of our daily lives, not only in figuring money but also in calculating time, distance, area, and many other quantities. In the auto-body trade, decimals are becoming more common, especially with the increased use of metric measurements. Subtraction is one of the basic mathematical operations done with decimals in the trade.

Set up each of the following problems in column form. Subtract and check your work. Remember, when you subtract decimals, the decimal points must be aligned. Refer to Information Sheet, Section XVIII if necessary.

A. $868.87 - 516.89 =$ _____

B. $567 - 19.856 =$ _____

C. $198 - 56.987 =$ _____

D. $567.94 - 59.78 =$ _____

E. $\$815.23 - \$65.98 =$ _____

ASSIGNMENT SHEET #14

F. $\$20.03 - \$15.88 =$ _____

G. $694.7 - 24.3 =$ _____

H. $5,000 - 892.66 =$ _____

I. $\$15 - \$12.53 =$ _____

J. $\$219.30 - \$21.85 =$ _____

- K. A technician keeps track of mileage driven on the job. At the beginning of the month, the vehicle odometer reads 29,268.4. At the end of the month, the odometer reads 29,872.1. How many miles were driven during the month?

Miles driven for month = _____

- L. A technician completed a restoration project and computed his profit. He sold the restored vehicle for \$6,500.00. How much profit did he make if his expenses were \$4,718.96?

Profit = _____

ASSIGNMENT SHEET #14

- M. A technician bought paint on sale. He had estimated the cost to be \$1,238.62 based on the regular price. How much did he save if the cost on sale was \$1,061.19?

Savings = _____

- N. The striping needed for a fleet of vehicles is estimated at 1,781 feet. A change is made to the estimate, reducing it by 264.5 feet. How much striping is required with this adjustment?

Amount of striping needed = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #15 — MULTIPLY DECIMAL NUMBERS

NAME _____

SCORE _____

Technicians are often required to calculate the area of a surface to determine the amount of materials needed. Additionally, costs and earnings may be calculated by multiplying with decimals—an essential skill for any good auto-body technician.

Multiplication with decimals is similar to multiplication with whole numbers. However, with decimals you must take care in placing the decimal point correctly. The number of decimal places in an answer must equal the total number of decimal places in the numbers that you multiplied.

EXAMPLE: 16.11 2 Decimal Places
 $\times$ 2.2 1 Decimal Place
 3222
 3222
 35.442 3 Decimal Places in Answer

Set up each of the following problems in column form and multiply. Locate the decimal point in the answer. Refer to Information Sheet, Section XIX if necessary.

A. $2.64 \times 3.1 =$ _____

B. $120 \times 0.33 =$ _____

C. $2.25 \times 0.51 =$ _____

ASSIGNMENT SHEET #15

D. $35 \times 8.5 =$ _____

E. $26.4 \times 3.8 =$ _____

F. $7.02 \times 0.92 =$ _____

G. $0.83 \times 0.55 =$ _____

H. $28.2 \times 0.9 =$ _____

I. $0.069 \times 0.01 =$ _____

ASSIGNMENT SHEET #15

J. $7.52 \times 3.01 =$ _____

- K. A tool kit is placed on sale for 25 percent off. How much is the price reduced if the regular price is \$1349.80?

(NOTE: Twenty-five percent is the same as the decimal 0.25.)

Price reduction = _____

- L. The average cost of a replacement part is \$41.25. During the year, the technician installs 150 such parts. What was the total cost?

Total cost = _____

- M. A technician buys 38 fasteners at a cost of \$3.49 each. What is the total cost?

Total cost = _____

- N. If the average weight of paint is 2.5 grams per square foot, what is the total weight (in grams) of the paint on a 831.75 square foot area?

Total weight = _____

MATH AND MEASURING UNIT IV

ASSIGNMENT SHEET #16 — DIVIDE DECIMAL NUMBERS

NAME _____

SCORE _____

A technician will usually have to shop around to find the best buys in tools and materials. Price comparisons often become difficult because not all suppliers base their prices on the same unit. Being able to divide decimal numbers will help a technician determine the best buys. Division with decimal numbers is also useful in figuring quantities of materials, weighing job opportunities, and in many other aspects of the trade.

Division with decimals is like division with whole numbers. However, before you begin to divide, you must decide where the decimal point should be placed in the number.

First study the divisor. If it has a decimal, move the decimal point to the right so that you change the decimal to a whole number. Then move the decimal point the same number of places to the right in the original number (number into which you are dividing).

EXAMPLE 1: Decimal point moved one place in both numbers.

$$\begin{array}{r} 2 \overline{)4} \\ 4 \\ 0 \end{array}$$

EXAMPLE 2: Decimal point moved two places in both numbers.

$$\begin{array}{r} .14 \overline{)14.028} \\ 14 \\ 0 \ 028 \\ 28 \\ 0 \end{array}$$

EXAMPLE 3: Decimal point moved one place in both numbers; note that a zero had to be added.

$$\begin{array}{r} 1.3 \overline{)26.0} \\ 26 \\ 00 \end{array}$$

EXAMPLE 4: No decimal point was moved to the right because 3 is already a whole number.

$$\begin{array}{r} 3 \overline{)6} \\ 6 \\ 0 \end{array}$$

ASSIGNMENT SHEET #16

Divide numbers in the following problems. Show your work. Refer to Information Sheet, Section XXI if necessary, and check your answers.

A. $4.5 \div 0.5 =$ _____

B. $4.96 \div 0.4 =$ _____

C. $19.8 \div 0.6 =$ _____

D. $10.71 \div 0.07 =$ _____

E. $0.225 \div 0.15 =$ _____

F. $1.7608 \div 0.0062 =$ _____

G. $0.48 \div 0.6 =$ _____

H. $0.125 \div 0.25 =$ _____

ASSIGNMENT SHEET #16

I. $0.9 + 0.003 =$ _____

J. $1.16 + 2.9 =$ _____

K. $75 + 0.03 =$ _____

L. $108 + 0.09 =$ _____

M. $84 + 0.007 =$ _____

N. $459 + 2.7 =$ _____

O. $406 + 0.029 =$ _____

P. What is the approximate cost per grinder disc if the cost of twelve discs is \$103.68?

Approximate cost = _____

ASSIGNMENT SHEET #16

- Q. How many hours did an auto-body technician work if she was paid a total of \$681.75 at the rate of \$22.50 per hour?

Total hours = _____

- R. How many jobs can be completed in a 21.12 hours if the average job takes 0.66 hours?

Number of jobs = _____

- S. A technician spent \$172.80 for paint. What was the cost per gallon of paint if he bought 8 gallons?

Cost per gallon = _____

- T. If it takes a technician 12.6 hours to mask a 1680 square-foot area, how long does it take him to mask 100 square feet?

Length of time = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #17 — CONVERT FRACTIONS AND PERCENTAGES

NAME _____ SCORE _____

In the auto-body trade, percentage is often useful. Percent means *per hundredths*. Five percent means *five one-hundredths* and may be written three ways: $\frac{5}{100}$, 0.05, and 5%. All have the *same* mathematical value.

Complete the following exercises. Refer to Information Sheet, Sections XXI through XXIII if necessary.

PART I

A. Express each of the following fractions as a decimal.

1. $\frac{1}{8} =$ _____

2. $\frac{1}{4} =$ _____

3. $\frac{1}{2} =$ _____

4. $\frac{3}{4} =$ _____

5. $\frac{5}{8} =$ _____

6. $\frac{1}{16} =$ _____

7. $\frac{3}{32} =$ _____

8. $\frac{7}{8} =$ _____

9. $\frac{9}{16} =$ _____

10. $\frac{15}{16} =$ _____

B. Express each of the following fractions as a percentage.

1. $\frac{1}{4} =$ _____

2. $\frac{1}{2} =$ _____

3. $\frac{7}{10} =$ _____

4. $\frac{3}{4} =$ _____

5. $\frac{2}{2} =$ _____

ASSIGNMENT SHEET #17

6. $\frac{1}{10} =$ _____

7. $\frac{7}{8} =$ _____

8. $\frac{5}{10} =$ _____

9. $\frac{1}{3} =$ _____

10. $\frac{5}{8} =$ _____

PART II

Fractions having denominators of ten, or one of the powers of ten (place values), are easily written as decimal numbers. Simply allow as many places to the right of the decimal point as there are zeros in the denominator.

EXAMPLES: $\frac{15}{10} = 1.5$ tenths

$\frac{125}{100} = 1.25$ hundredths

$\frac{1125}{1000} = 1.125$ thousandths

A. Match the decimal numbers on the right to their correct equivalent fractions. Write the correct letters in the blanks.

_____ 1. $\frac{58}{10}$

a. 7.083

_____ 2. $\frac{12}{100}$

b. 5.006

_____ 3. $\frac{87}{1000}$

c. 78.3

_____ 4. $\frac{783}{1000}$

d. 0.087

_____ 5. $\frac{58}{100}$

e. 0.783

_____ 6. $\frac{58}{1000}$

f. 87.7

_____ 7. $\frac{783}{10}$

g. 5.6

_____ 8. $\frac{877}{10}$

h. 102.0

_____ 9. 102

i. 5.06

_____ 10. $\frac{783}{1000}$

j. 1.02

ASSIGNMENT SHEET #17

B. Write decimal equivalents for each of the following fractions.

- | | |
|----------------------------------|-------------------------------------|
| 1. $63^{\circ}/_{10} =$ _____ | 6. $38^{\circ}/_{100} =$ _____ |
| 2. $5^{\circ}/_{100} =$ _____ | 7. $38^{\circ}/_{1000} =$ _____ |
| 3. $5^{\circ}/_{1000} =$ _____ | 8. $42^{\circ}/_{10} =$ _____ |
| 4. $5^{\circ}/_{10000} =$ _____ | 9. $402^{\circ}/_{10} =$ _____ |
| 5. $382^{\circ}/_{1000} =$ _____ | 10. $897^{\circ}/_{100000} =$ _____ |

PART III

A. Express each of the following percentages as a fraction. Reduce to lowest terms.

1. 50% = _____
2. 25% = _____
3. $33\frac{1}{3}\%$ = _____
4. 36% = _____
5. 28% = _____
6. $14\frac{2}{7}\%$ = _____
7. 21% = _____
8. 75% = _____
9. $66\frac{2}{3}\%$ = _____
10. 70% = _____

B. Express each of the following percentages as a decimal.

- | | |
|------------------|------------------|
| 1. 47% = _____ | 6. 3% = _____ |
| 2. 15% = _____ | 7. 16.8% = _____ |
| 3. 33.3% = _____ | 8. 9% = _____ |
| 4. 62% = _____ | 9. 10% = _____ |
| 5. 75% = _____ | 10. 50% = _____ |

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #18 — SOLVE PERCENTAGE PROBLEMS

NAME _____ SCORE _____

In the auto-body trade, you will frequently encounter percentages. Interest rates, pricing discounts, waste allowances, and many other factors that affect the industry are stated as percentages. To make the most of your career in this field, you must understand what percentages mean and how they are used.

Solve the following percentage problems. Refer to Information Sheet, Section XXIV if necessary.

PART I

- A. What does it mean to say 100 percent of the work is completed? _____

- B. There are usually 100 tools in the tool room. Fourteen of them are missing. What percent of the tools are missing? _____
- C. If 14 of the tools are missing in the above problem, how many are present? _____
What percent are present? _____
- D. There are 100 sanding discs in a stack. Twenty-five discs are what percent of the discs in the stack? _____
Five discs are what percent of the discs in the stack? _____

ASSIGNMENT SHEET #18

- E. There are 100 body jobs scheduled for the month. Ninety-four have been completed. What percent of the jobs have been completed? _____
- F. If 94 of the jobs in the above problem have been completed, how many have not been?

What percent have not been completed? _____
- G. If 11 percent of the employees in the shop are absent, what percent are present? _____
- H. If 6 percent of a paint is acrylic, what percent is not acrylic? _____
- I. Gene McGill bought a new impact wrench—regularly selling for \$120—at a sale and saved 20 percent. How much did he save? _____
- J. Betty Chester's repair shop had a 20 percent increase in business this year over last year. How much was the increase if her shop did \$286,410.00 worth of business last year?

ASSIGNMENT SHEET #18

- K. Susan has three types of screwdrivers—flat, Philips, and square. Eighty percent of her screwdrivers are flat, and 15 percent are square. What percent are Philips? _____
- L. The Smiths spent 22 percent of their income for their business: 17 percent for tools, 15 percent for work clothes, and 8 percent for entertainment. What percent was left for other things? _____
- M. Chester has finished 75 percent of the job he is doing. What percent does he still have to do? _____
- N. Betty has completed 40 percent of her training. What percent does she still have to do? _____
- O. If you were told to complete 93 percent of the work, what percent would be left? _____

ASSIGNMENT SHEET #18

PART II

Solve each of the following percentage problems.

- A. 3% of 72 is what number? _____
- B. 5% of 18 is what number? _____
- C. What number is $33\frac{1}{3}\%$ of 96? _____
- D. 40% of 125 is what number? _____
- E. 68% of 63.5 is what number? _____
- F. What number is $12\frac{1}{2}\%$ of 140.8? _____
- G. What number is 1% of 103? _____
- H. What number is $37\frac{1}{2}\%$ of 152? _____
- I. 50% of 32.8 is what number? _____
- J. 7% of 163 is what number? _____

ASSIGNMENT SHEET #18

PART III

Solve the following percentage word problems. Show your work.

- A. There are 20 technicians in the shop. Sixty percent of the technicians are over twenty-two years old. How many technicians are over twenty-two years old? _____
- B. One day 5 percent of the 20 technicians in Mr. Moore's group made perfect time completing a job. How many technicians made perfect time? _____
- C. Tony Martinez bought a new sander—regularly selling for \$120—at a sale and saved 12 percent. How much money did he save? _____
- D. The number of technicians at the state meeting this week was 75 percent of what it was last week. Last week there were 800 technicians at the meeting. How many technicians were at the meeting this week? _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #19 — SOLVE BASIC RATIO AND PROPORTION PROBLEMS

NAME _____ SCORE _____

The auto-body trade uses ratios and proportions primarily in mixing paints. The technician will be required to calculate some ratios and proportions, and may be required to apply others.

Solve the following ratio and proportion problems. Refer to Information Sheet, Section XXV if necessary. Show your work.

- A. Convert the ratio 0.25:0.25:1 to the smallest proportion possible containing whole numbers.

Proportion = _____

- B. What would be the proportion if a 1:2:12 mix were cut in half?

Proportion = _____

- C. What would be the proportion if the ratio 1:1:3 were tripled?

Proportion = _____

- D. You are asked to mix a solution of paint using a 1:1:6 ratio, but you will need six times this amount. What will be the proportion of material needed?

Proportion = _____

- E. A mixture of 1 part reducer, 1 part paint, and 3 parts enamel is needed to make 25 pints of paint. How many pints of each are needed?

Pints reducer = _____

Pints pigment = _____

Pints enamel = _____

MATH AND MEASURING
UNIT IV

ASSIGNMENT SHEET #20 — READ MEASUREMENTS ON A RULE

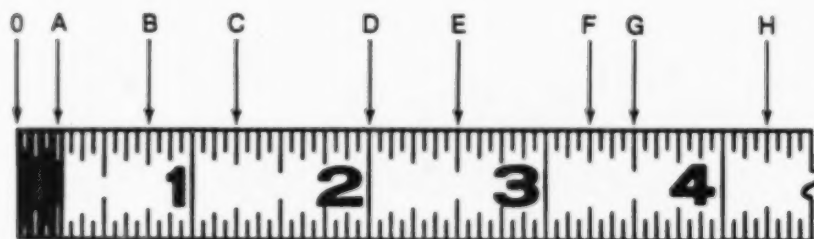
NAME _____

SCORE _____

The first step in being able to make accurate measurements is to become familiar with the graduations on rules and how to read them. This assignment sheet will allow you to practice reading measurements on a rule.

PART I

- A. Read the rule illustrated below to the nearest quarter inch. Write your answers on the lines provided.



- | | |
|-------------------|--------------------|
| 1. 0 to A = _____ | 6. 0 to E = _____ |
| 2. A to B = _____ | 7. C to E = _____ |
| 3. 0 to C = _____ | 8. B to F = _____ |
| 4. A to D = _____ | 9. D to G = _____ |
| 5. B to D = _____ | 10. A to H = _____ |

ASSIGNMENT SHEET #20

- B. Read the rule illustrated below to the nearest eighth inch. Write your answers on the lines provided.



1. 0 to A = _____
 2. A to B = _____
 3. 0 to C = _____
 4. B to D = _____
 5. A to E = _____
 6. 0 to F = _____
 7. D to E = _____
 8. C to G = _____
 9. A to H = _____
 10. E to H = _____
- C. Read the rule illustrated below to the nearest sixteenth inch. Write your answers on the lines provided.



1. 0 to A = _____
2. A to B = _____
3. 0 to C = _____
4. B to D = _____
5. A to E = _____
6. 0 to F = _____
7. C to F = _____
8. A to G = _____
9. 0 to H = _____
10. E to H = _____

ASSIGNMENT SHEET #20

- D. Read the rule illustrated below to the nearest one-thirty-seconds inch. Write your answers on the lines provided.



- | | |
|-------------------|--------------------|
| 1. 0 to A = _____ | 6. B to E = _____ |
| 2. 0 to B = _____ | 7. C to F = _____ |
| 3. A to B = _____ | 8. B to G = _____ |
| 4. 0 to C = _____ | 9. 0 to H = _____ |
| 5. A to D = _____ | 10. D to H = _____ |

PART II

Measure the following objects, using a rule graduated in sixteenths of an inch.

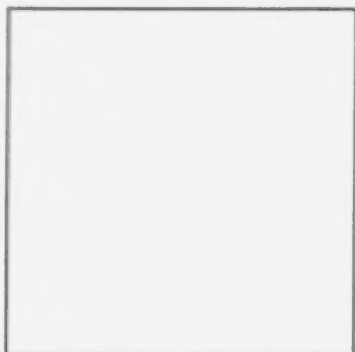
A.



1. Length = _____
2. Width = _____

ASSIGNMENT SHEET #20

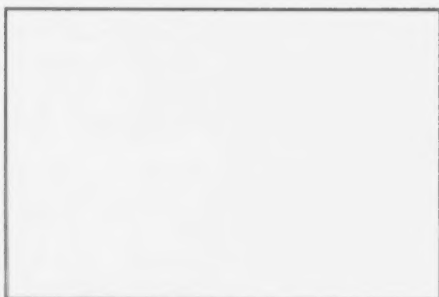
B.



1. Length = _____

2. Width = _____

C.



1. Length = _____

2. Width = _____

D. Your instructor will indicate objects and structures in your shop area for you to measure. Measure the objects and write down the dimensions.

MATH AND MEASURING
UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

Part I

- | | |
|--------|-----------|
| A. 11 | F. 88 |
| B. 16 | G. 242 |
| C. 13 | H. 1538 |
| D. 23 | I. 1917 |
| E. 108 | J. 16,430 |

Part II

- A. 1175 lineal feet
B. 1135 fasteners
C. \$609
D. 12,130 square feet

Assignment Sheet #2

Part I

- | | |
|--------|-----------|
| A. 4 | F. 283 |
| B. 7 | G. 1175 |
| C. 53 | H. 1810 |
| D. 406 | I. 51,450 |
| E. 424 | J. 89,722 |

Part II

- A. 126 shop towels
B. 1160 square feet
C. 948 jobs
D. 134 hours

Assignment Sheet #3

Part I

- | | |
|---------|--------------|
| A. 42 | F. 2028 |
| B. 72 | G. 21,291 |
| C. 324 | H. 165,478 |
| D. 2884 | I. 503,605 |
| E. 8410 | J. 5,458,852 |

Part II

- A. 450 yards
B. 8160 square feet
C. 2850 lineal feet
D. 1440 hours

Assignment Sheet #4

Part I

- | | |
|--------|-------------|
| A. 4 | F. 3 |
| B. 8 | G. 62, R 4 |
| C. 91 | H. 2, R 97 |
| D. 312 | I. 1, R 365 |
| E. 3 | J. 3, R 634 |

Part II

- A. 28 automobiles per week
B. 9 trucks per week with 1 truck left over
C. $97\frac{1}{2}$ lineal feet
D. 4 fans

Assignment Sheet #5

Part I

- A. 1. 5,8
2. numerator, denominator
3. 1,4
- B. 1. $\frac{10}{16}$
2. $\frac{16}{32}$
- C. 1. 1
2. 8
3. $\frac{1}{8}$

ANSWERS TO ASSIGNMENT SHEETS

Part II

- | | | |
|----|------|-------|
| A. | 1. n | 9. b |
| | 2. d | 10. g |
| | 3. f | 11. m |
| | 4. k | 12. c |
| | 5. a | 13. h |
| | 6. j | 14. o |
| | 7. i | 15. e |
| | 8. l | |

- B. Evaluated to the satisfaction of the instructor

Assignment Sheet #6

- | | | | |
|----|---------------|----|---------------|
| A. | $\frac{1}{2}$ | F. | $\frac{3}{8}$ |
| B. | $\frac{1}{2}$ | G. | $\frac{1}{2}$ |
| C. | 1 | H. | $\frac{1}{2}$ |
| D. | $\frac{1}{4}$ | I. | $\frac{3}{4}$ |
| E. | $\frac{1}{4}$ | J. | $\frac{1}{2}$ |

Assignment Sheet #7

Part I

- | | | | |
|----|----|----|----|
| A. | 4 | G. | 18 |
| B. | 8 | H. | 9 |
| C. | 3 | I. | 6 |
| D. | 5 | J. | 28 |
| E. | 3 | K. | 3 |
| F. | 20 | L. | 7 |

Part II

- A. $\frac{9}{16}$ and $\frac{9}{16}$
 B. $\frac{99}{128}$ and $\frac{39}{128}$
 C. $\frac{9}{128}$ and $\frac{80}{128}$
 D. $\frac{16}{32}$ and $\frac{14}{32}$
 E. $\frac{1536}{2048}$ and $\frac{1152}{2048}$ and $\frac{448}{2048}$

Part III

- A. $\frac{9}{20}$ and $\frac{5}{20}$
 B. $\frac{32}{48}$ and $\frac{9}{48}$
 C. $\frac{24}{32}$ and $\frac{9}{32}$
 D. $\frac{9}{16}$ and $\frac{7}{16}$
 E. $\frac{30}{40}$ and $\frac{25}{40}$ and $\frac{20}{40}$

Assignment Sheet #8

Part I

- | | | |
|----|------|-------|
| A. | 1. P | 9. I |
| | 2. M | 10. M |
| | 3. I | 11. M |
| | 4. M | 12. I |
| | 5. P | 13. I |
| | 6. I | 14. P |
| | 7. I | 15. M |
| | 8. M | |

- B. Evaluated to the satisfaction of the instructor

- C. Evaluated to the satisfaction of the instructor

Part II

- | | | |
|----|--------------------|---------------------|
| A. | 1. $1\frac{3}{4}$ | 6. $1\frac{1}{2}$ |
| | 2. $\frac{9}{2}$ | 7. $1\frac{7}{4}$ |
| | 3. $3\frac{1}{4}$ | 8. $1\frac{7}{2}$ |
| | 4. $1\frac{7}{2}$ | 9. $3\frac{7}{4}$ |
| | 5. $4\frac{9}{8}$ | 10. $3\frac{3}{2}$ |
| B. | 1. $1\frac{3}{4}$ | 6. $1\frac{3}{8}$ |
| | 2. $4\frac{1}{2}$ | 7. $2\frac{11}{32}$ |
| | 3. $1\frac{1}{2}$ | 8. $2\frac{1}{2}$ |
| | 4. $1\frac{7}{8}$ | 9. $3\frac{3}{4}$ |
| | 5. $1\frac{3}{16}$ | 10. $2\frac{1}{16}$ |

Assignment Sheet #9

- | | | | |
|----|-----------------|----|------------------------|
| A. | $\frac{1}{2}$ | G. | $\frac{15}{16}$ |
| B. | 1 | H. | $\frac{125}{32}$ |
| C. | $\frac{23}{32}$ | I. | $\frac{5}{8}$ gallon |
| D. | $1\frac{3}{16}$ | J. | $1\frac{3}{32}$ inches |
| E. | $\frac{29}{32}$ | K. | $1\frac{3}{16}$ inches |
| F. | $1\frac{3}{16}$ | L. | $4\frac{3}{8}$ inches |

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #10

- | | |
|-------------------|----------------------------|
| A. $\frac{9}{16}$ | I. $\frac{17}{32}$ |
| B. $\frac{5}{8}$ | J. $\frac{1}{2}$ |
| C. $\frac{3}{16}$ | K. $\frac{1}{2}$ inch |
| D. $\frac{5}{32}$ | L. $\frac{3}{32}$ inch |
| E. $\frac{3}{4}$ | M. $\frac{1}{8}$ inch |
| F. $\frac{9}{16}$ | N. $23\frac{7}{64}$ inches |
| G. $\frac{1}{16}$ | O. $13\frac{1}{4}$ inches |
| H. $\frac{3}{8}$ | |

Assignment Sheet #11

- | | |
|----------------------|---------------------------|
| A. $\frac{3}{8}$ | G. $\frac{1}{24}$ |
| B. $15\frac{1}{128}$ | H. $16\frac{27}{32}$ |
| C. $3\frac{3}{8}$ | I. $\frac{1}{4}$ gallon |
| D. $3\frac{1}{4}$ | J. 74 fasteners |
| E. $7\frac{1}{12}$ | K. $4\frac{1}{3}$ gallons |
| F. $1\frac{1}{2}$ | L. $7\frac{1}{8}$ inch |

Assignment Sheet #12

- | | |
|---------------------|-------------------------------|
| A. $\frac{2}{3}$ | G. $11\frac{1}{3}$ |
| B. $1\frac{1}{5}$ | H. 40 |
| C. $\frac{2}{3}$ | I. $8\frac{1}{12}$ feet |
| D. $4\frac{1}{6}$ | J. $19\frac{9}{10}$ gallons |
| E. $11\frac{5}{16}$ | K. $5\frac{1}{4}$ automobiles |
| F. $2\frac{1}{4}$ | L. $88\frac{3}{132}$ circuits |

Assignment Sheet #13

- | | |
|-------------|-----------------|
| A. 0.189 | I. 6.455 |
| B. 1.072 | J. 30024.88 |
| C. \$9.22 | K. 56.000 |
| D. 0.0102 | L. 0.87139 |
| E. \$71.01 | M. \$164.80 |
| F. \$131.32 | N. 27.9 hours |
| G. 287.706 | O. \$122.71 |
| H. 0.4000 | P. 1366.6 miles |

Assignment Sheet #14

- | | |
|-------------|----------------|
| A. 351.98 | H. 4107.34 |
| B. 547.144 | I. \$2.47 |
| C. 141.013 | J. \$197.45 |
| D. 508.16 | K. 603.7 miles |
| E. \$749.25 | L. \$1781.04 |
| F. \$4.15 | M. \$177.43 |
| G. 670.4 | N. 1516.5 feet |

Assignment Sheet #15

- | | |
|-----------|-------------------|
| A. 8.184 | H. 25.38 |
| B. 39.6 | I. 0.00069 |
| C. 1.1475 | J. 22.6352 |
| D. 297.5 | K. \$337.45 |
| E. 100.32 | L. \$6,187.50 |
| F. 6.4584 | M. \$132.62 |
| G. 0.4565 | N. 2079.375 grams |

Assignment Sheet #16

- | | |
|---------|---------------|
| A. 9 | K. 2500 |
| B. 12.4 | L. 1200 |
| C. 33 | M. 12,000 |
| D. 153 | N. 170 |
| E. 1.5 | O. 14,000 |
| F. 284 | P. \$8.64 |
| G. 0.8 | Q. 30.3 hours |
| H. 0.5 | R. 32 jobs |
| I. 300 | S. \$21.60 |
| J. 0.4 | T. 0.75 hours |

Assignment Sheet #17

Part I

- | | |
|-------------|------------|
| A. 1. 0.125 | 6. 0.0625 |
| 2. 0.25 | 7. 0.09375 |
| 3. 0.5 | 8. 0.875 |
| 4. 0.75 | 9. 0.5625 |
| 5. 0.625 | 10. 0.9375 |

ANSWERS TO ASSIGNMENT SHEETS

- B. 1. 25% 6. 10%
 2. 50% 7. 87.5%
 3. 70% 8. 50%
 4. 75% 9. 33.3%
 5. 100% 10. 62.5%

Part II

- A. 1. g 6. b
 2. j 7. c
 3. d 8. f
 4. a 9. h
 5. i 10. e

- B. 1. 63.9 6. 38.95
 2. 5.93 7. 38.095
 3. 5.093 8. 42.3
 4. 5.0093 9. 402.3
 5. 3.825 10. 897.00097

Part III

- A. 1. $\frac{1}{2}$ 6. $\frac{1}{7}$
 2. $\frac{1}{4}$ 7. $\frac{21}{100}$
 3. $\frac{1}{3}$ 8. $\frac{3}{4}$
 4. $\frac{9}{25}$ 9. $\frac{2}{3}$
 5. $\frac{7}{25}$ 10. $\frac{7}{10}$

- B. 1. 0.47 6. 0.03
 2. 0.15 7. 0.168
 3. 0.333 8. 0.09
 4. 0.62 9. 0.10
 5. 0.75 10. 0.50

Assignment Sheet #18

Part I

- A. All work is completed H. 94%
 B. 14% I. \$24.00
 C. 86, 86% J. \$9807.24
 D. 25%, 5% K. 5%
 E. 94% L. 38%
 F. 6, 6% M. 25%
 G. 89% N. 60%
 O. 7%

Part II

- A. 2.16 F. 17.6
 B. 0.9 G. 1.03
 C. 32 H. 57
 D. 50 I. 16.4
 E. 43.18 J. 11.41

Part III

- A. 12
 B. 1
 C. \$14.40
 D. 600

Assignment Sheet #19

- A. 1:1:4
 B. 0.5:1:6
 C. 3:3:9
 D. 6:6:36
 E. 5 pints reducer
 5 pints pigment
 15 pints enamel

Assignment Sheet #20

Part I

- A. 1. $\frac{1}{4}$ " 6. $2\frac{1}{2}$ "
 2. $\frac{1}{2}$ " 7. $1\frac{1}{4}$ "
 3. $1\frac{1}{4}$ " 8. $2\frac{1}{2}$ "
 4. $1\frac{3}{4}$ " 9. $1\frac{1}{2}$ "
 5. $1\frac{1}{4}$ " 10. 4"

- B. 1. $\frac{3}{8}$ " 6. $2\frac{3}{4}$ "
 2. $\frac{1}{4}$ " 7. $1\frac{3}{8}$ "
 3. $1\frac{1}{8}$ " 8. 2"
 4. $\frac{3}{4}$ " 9. $3\frac{7}{8}$ "
 5. $1\frac{1}{2}$ " 10. $2\frac{3}{8}$ "

- C. 1. $1\frac{5}{16}$ " 6. $3\frac{5}{16}$ "
 2. $\frac{1}{2}$ " 7. $1\frac{1}{2}$ "
 3. $1\frac{3}{16}$ " 8. $2\frac{5}{8}$ "
 4. $\frac{3}{4}$ " 9. $4\frac{1}{4}$ "
 5. $1\frac{1}{16}$ " 10. $1\frac{5}{8}$ "

ANSWERS TO ASSIGNMENT SHEETS

- D.
- | | |
|-----------------------|------------------------|
| 1. $\frac{25}{32}$ " | 6. $1\frac{1}{2}$ " |
| 2. $\frac{15}{32}$ " | 7. $1\frac{3}{16}$ " |
| 3. $\frac{3}{8}$ " | 8. $2\frac{13}{16}$ " |
| 4. $1\frac{27}{32}$ " | 9. $4\frac{9}{32}$ " |
| 5. $1\frac{9}{16}$ " | 10. $1\frac{15}{16}$ " |

Part II

- A.
1. $4\frac{5}{16}$ inches
 2. $2\frac{13}{16}$ inches
- B.
1. 2 inches
 2. 2 inches
- C.
1. $2\frac{8}{16}$ inches = $2\frac{1}{2}$
 2. $1\frac{10}{16}$ inches = $1\frac{5}{8}$
- D. Evaluated to the satisfaction of the instructor

MATH AND MEASURING
UNIT IV

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with basic math. Write the correct numbers in the blanks.

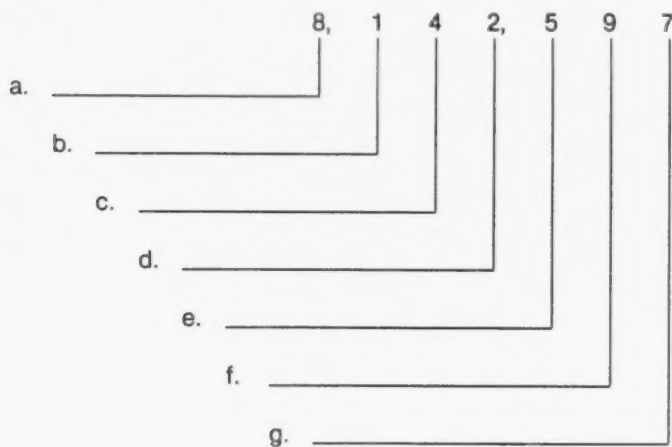
- | | |
|--|---------------------------|
| _____a. Process of totaling two or more numbers to find another number called a sum | 1. Digit |
| _____b. Fraction with an unwritten denominator of 10 or some power of 10; indicated with a point before the number | 2. Multiplication |
| _____c. Any one of the ten symbols, 0 to 9, by which all numbers can be expressed | 3. Subtraction |
| _____d. Opposite (inverse) operation of multiplication | 4. Whole number (integer) |
| _____e. Part of a whole; represents one or more equal parts of a unit | 5. Addition |
| _____f. Any of the natural numbers, both positive and negative, that represents a complete item | 6. Fraction |
| _____g. Abbreviated process of adding a number to itself a specified number of times | 7. Ratio |
| _____h. One part in a hundred; reckoned on the basis of a whole divided into one hundred parts | 8. Proportional |
| _____i. Being relatively equal in size or quantity | 9. Division |
| _____j. Relationship in quantity, amount, or size between two or more things | 10. Decimal |
| _____k. Opposite (inverse) operation of addition | 11. Percent |

TEST

2. Match to their correct names symbols used in math problems. Write the correct numbers in the blanks.

_____ a. Plus sign (addition)	1. =
_____ b. Pi sign	2. $\times$
_____ c. Equal sign	3. -
_____ d. Division frame	4. $\div$
_____ e. Ratio symbol	5. +
_____ f. Minus sign (subtraction)	6. .
_____ g. Percent symbol	7. π
_____ h. Times sign (multiplication)	8. %
_____ i. Decimal point	9. :
_____ j. Division sign	10. $\overline{)$

3. Label the place values in the whole number below.



TEST

4. Add whole numbers to solve the following problems. Show your work.

a.
$$\begin{array}{r} 2 \\ + 9 \\ \hline \end{array}$$

b.
$$\begin{array}{r} 5 \\ 7 \\ + 8 \\ \hline \end{array}$$

c.
$$\begin{array}{r} 12 \\ 17 \\ + 99 \\ \hline \end{array}$$

d.
$$\begin{array}{r} 142 \\ 759 \\ + 896 \\ \hline \end{array}$$

e.
$$\begin{array}{r} 2345 \\ 9764 \\ + 8976 \\ \hline \end{array}$$

5. Subtract whole numbers to solve the following problems. Check your answers and show your work.

a.
$$\begin{array}{r} 9 \\ - 7 \\ \hline \end{array}$$

b.
$$\begin{array}{r} 35 \\ - 9 \\ \hline \end{array}$$

c.
$$\begin{array}{r} 481 \\ - 79 \\ \hline \end{array}$$

d.
$$\begin{array}{r} 684 \\ - 342 \\ \hline \end{array}$$

e.
$$\begin{array}{r} 9867 \\ - 8748 \\ \hline \end{array}$$

6. Multiply whole numbers to solve the following problems. Show your work.

a.
$$\begin{array}{r} 7 \\ \times 5 \\ \hline \end{array}$$

b.
$$\begin{array}{r} 68 \\ \times 9 \\ \hline \end{array}$$

c.
$$\begin{array}{r} 735 \\ \times 68 \\ \hline \end{array}$$

d.
$$\begin{array}{r} 649 \\ \times 537 \\ \hline \end{array}$$

e.
$$\begin{array}{r} 8673 \\ \times 642 \\ \hline \end{array}$$

7. Divide whole numbers to solve the following problems. Show your work.

a. $4 \overline{)48}$

b. $16 \overline{)64}$

c. $38 \overline{)608}$

TEST

d. $421 \overline{)842}$

e. $317 \overline{)4569}$

f. $530 \overline{)80960}$

8. Distinguish among types of fractions. Write a "P" in the blanks before proper fractions, an "I" before improper fractions, and an "M" in the blanks before mixed numbers.

_____ a. $\frac{1}{2}$

_____ f. $\frac{10}{32}$

_____ b. $8\frac{3}{4}$

_____ g. $\frac{2}{8}$

_____ c. $\frac{8}{8}$

_____ h. $6\frac{1}{2}$

_____ d. $15\frac{3}{8}$

_____ i. $\frac{1}{4}$

_____ e. $5\frac{3}{16}$

_____ j. $\frac{99}{1}$

9. Reduce the following fractions to lowest terms. Write your answers in the blanks.

_____ a. $\frac{4}{18}$

_____ f. $\frac{4}{18}$

_____ b. $\frac{8}{16}$

_____ g. $\frac{2}{16}$

_____ c. $\frac{7}{16}$

_____ h. $\frac{8}{64}$

_____ d. $\frac{8}{32}$

_____ i. $\frac{12}{16}$

_____ e. $\frac{12}{32}$

_____ j. $\frac{31}{32}$

10. Convert the following mixed numbers to improper fractions. Reduce to lowest terms if possible. Write your answers in the blanks.

_____ a. $3\frac{1}{2}$

_____ b. $4\frac{2}{4}$

_____ c. $3\frac{6}{8}$

_____ d. $12\frac{4}{8}$

_____ e. $13\frac{13}{32}$

TEST

11. Convert the following improper fractions to mixed numbers. Reduce answers to lowest terms. Write your answers in the blanks.

_____ a. $\frac{47}{8}$

_____ b. $\frac{21}{9}$

_____ c. $\frac{108}{23}$

_____ d. $\frac{54}{5}$

_____ e. $\frac{112}{7}$

12. Add fractions to solve the following problems. Convert to mixed numbers if necessary, and reduce to lowest terms. Write your answers in the blanks.

_____ a. $\frac{1}{8} + \frac{5}{8}$

_____ b. $\frac{1}{16} + \frac{15}{16}$

_____ c. $\frac{2}{4} + \frac{3}{4}$

_____ d. $\frac{1}{2} + \frac{4}{8}$

_____ e. $\frac{4}{8} + \frac{2}{4}$

_____ f. $\frac{7}{8} + \frac{6}{16}$

_____ g. $2\frac{1}{8} + 7\frac{1}{4}$

_____ h. $3\frac{2}{4} + 16\frac{1}{8}$

_____ i. $4\frac{2}{4} + 8\frac{2}{8}$

_____ j. $5\frac{1}{8} + 6\frac{2}{16}$

13. Subtract fractions to solve the following problems. Reduce answers to lowest terms. Write your answers in the blanks.

_____ a. $\frac{4}{8} - \frac{3}{8}$

_____ b. $\frac{6}{8} - \frac{2}{8}$

_____ c. $\frac{9}{16} - \frac{4}{16}$

_____ d. $\frac{3}{8} - \frac{1}{4}$

_____ e. $\frac{3}{8} - \frac{1}{8}$

_____ f. $\frac{14}{16} - \frac{7}{8}$

_____ g. $2\frac{3}{4} - 1\frac{1}{4}$

_____ h. $6\frac{1}{8} - 2\frac{1}{2}$

_____ i. $9\frac{2}{4} - 4\frac{1}{2}$

_____ j. $12\frac{6}{8} - 7\frac{1}{8}$

TEST

14. Multiply fractions to solve the following problems. Reduce to lowest terms. Write your answers in the blanks.

_____ a. $\frac{1}{2} \times \frac{3}{4}$

_____ b. $\frac{3}{4} \times \frac{3}{8}$

_____ c. $\frac{3}{2} \times \frac{1}{16}$

_____ d. $\frac{3}{4} \times 6\frac{1}{2}$

_____ e. $6\frac{3}{4} \times 8\frac{3}{4}$

_____ f. $7\frac{1}{8} \times 1\frac{1}{2}$

_____ g. $\frac{77}{16} \times 5$

15. Divide fractions to solve the following problems. Reduce to lowest terms. Write your answers in the blanks.

_____ a. $\frac{7}{8} \div \frac{1}{4}$

_____ b. $3\frac{1}{4} \div 1\frac{5}{6}$

_____ c. $10\frac{1}{8} \div \frac{1}{8}$

_____ d. $4\frac{1}{5} \div 2\frac{1}{3}$

_____ e. $6\frac{7}{8} \div \frac{3}{4}$

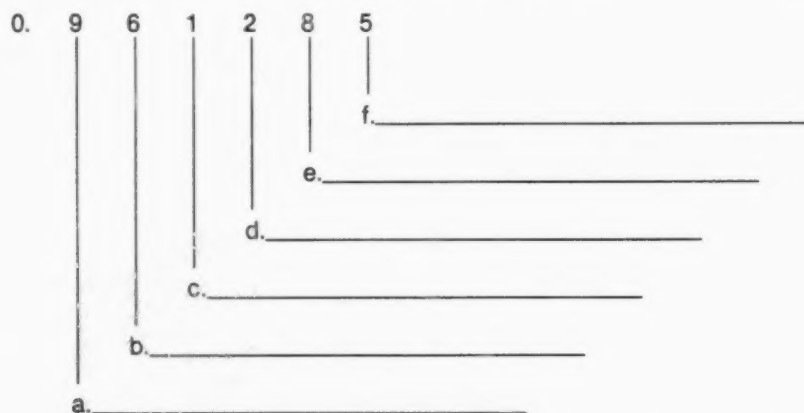
_____ f. $2\frac{1}{2} \div 1\frac{3}{5}$

_____ g. $\frac{5}{6} \div \frac{1}{8}$

_____ f. $4\frac{1}{2} \div 3$

TEST

16. Label the place values in the decimal number below.



17. Add decimal numbers to solve the following problems. Set up each problem and show your work. Write your answers in the blanks.

_____ a. $3.5 + 5.1 + 7$

_____ b. $3.4 + 0.206 + 1.74$

_____ c. $\$6.86 + \$5.05 + \$7.90 + \$8.82$

_____ d. $57.78 + 0.22 + 0.003 + 74$

_____ e. $6319 + 95.12 + 0.0713 + 321.07$

TEST

18. Subtract decimal numbers to solve the following problems. Set up each problem and check your work. Write your answers in the blanks.

_____ a. $\$6.10 - \$2.20$

_____ b. $\$5.40 - \$2.32$

_____ c. $\$7.38 - \$6.63$

_____ d. $0.835325 - 0.25$

_____ e. $0.609375 - 0.359375$

19. Multiply decimal numbers to solve the following problems. Set up each problem and show your work. Write your answers in the blanks.

_____ a. 2.6×4.7

_____ b. 0.119×0.05

TEST

_____c. 9×0.08

_____d. 7.392×92.07

_____e. 9.5×0.76

20. Divide decimals to solve the following problems. Set up each problem and check your work. Write your answers in the blanks.

_____a. $5.32 \div 0.4$

_____b. $83.4 \div 0.6$

_____c. $7.75 \div 0.25$

TEST

_____d. $0.921 \div 0.3$

_____e. $0.0225 \div 0.15$

_____f. $24 \div 0.2$

_____g. $54 \div 0.09$

_____h. $63 \div 0.007$

_____i. $812 \div 0.058$

TEST

_____ j. $4215 \div 0.040$

21. Convert the following fractions to decimal numbers and percentages. Give percentages in the nearest whole percent. Write your answers in the blanks.

Decimal Number	Percentage
_____	_____ a. $\frac{1}{3}$
_____	_____ b. $\frac{3}{25}$
_____	_____ c. $23\frac{3}{100}$
_____	_____ d. $11\frac{24}{1000000}$
_____	_____ e. $\frac{7}{16}$
_____	_____ f. $\frac{2}{7}$
_____	_____ g. $8\frac{13}{100000}$
_____	_____ h. $\frac{5}{6}$
_____	_____ i. $18\frac{3}{10}$
_____	_____ j. $5\frac{5}{1000}$

TEST

22. Identify decimal and fractional equivalents. Write the correct answers in the blanks.

	$\frac{1}{64}$	.015625
$\frac{1}{32}$		.03125
	$\frac{3}{64}$	.046875
$\frac{1}{16}$		.0625
	$\frac{5}{64}$	.078125
$\frac{3}{32}$		.09375
	$\frac{7}{64}$	.109375
a. $\frac{\quad}{\quad}$		.125
	$\frac{9}{64}$	.140625
$\frac{5}{32}$		.15625
	$\frac{11}{64}$	.171875
$\frac{3}{16}$		.1875
	$\frac{13}{64}$	.203125
$\frac{7}{32}$		.21875
	$\frac{15}{64}$	.234375
$\frac{1}{4}$		b. _____
	$\frac{17}{64}$	.265625
$\frac{9}{32}$		.28125
	$\frac{19}{64}$	.296875
$\frac{5}{16}$		.3125
	$\frac{21}{64}$	.328125
$\frac{11}{32}$		.34375
	$\frac{23}{64}$	.359375
c. $\frac{\quad}{\quad}$		.375
	$\frac{25}{64}$	.390625
$\frac{13}{32}$		.40625
	$\frac{27}{64}$	.421875
$\frac{7}{16}$		.4375
	$\frac{29}{64}$	.453125
$\frac{15}{32}$		.46875
	$\frac{31}{64}$	.484375
$\frac{1}{2}$		d. _____

	$\frac{33}{64}$	.515625
$\frac{17}{32}$		.53125
	$\frac{35}{64}$	.546875
$\frac{9}{16}$		.5625
	$\frac{37}{64}$	.578125
$\frac{19}{32}$		.59375
	$\frac{39}{64}$	.609375
$\frac{5}{8}$		e. _____
	$\frac{41}{64}$	.640625
$\frac{21}{32}$		.65625
	$\frac{43}{64}$	.671875
$\frac{11}{16}$		.6875
	$\frac{45}{64}$	.703125
$\frac{23}{32}$		.71875
	$\frac{47}{64}$	.734375
f. $\frac{\quad}{\quad}$		.75
	$\frac{49}{64}$	.765625
$\frac{25}{32}$		.78125
	$\frac{51}{64}$	.796875
$\frac{13}{16}$		.8125
	$\frac{53}{64}$	.828125
$\frac{27}{32}$		.84375
	$\frac{55}{64}$	.859375
$\frac{7}{8}$		g. _____
	$\frac{57}{64}$	.890625
$\frac{29}{32}$		.90625
	$\frac{59}{64}$	.921875
$\frac{15}{16}$		.9375
	$\frac{61}{64}$	.953125
$\frac{31}{32}$		.96875
	$\frac{63}{64}$	.984375
1		h. _____

TEST

23. Convert the following percentages to fractions and decimal numbers. Write your answers in the blanks.

Decimal Number	Fraction
_____	_____ a. 12%
_____	_____ b. 30%
_____	_____ c. 45%
_____	_____ d. 72%
_____	_____ e. 250%

24. Solve the following percentage problems. Write your answers in the blanks.

- _____ a. If an employer paid a technician \$150.00, which is 87 percent of his salary, how much more money would the technician have coming?
- _____ b. If 12 percent of the solvent for the shop has been used, how much would be left of the 2100 gallons stored?
- _____ c. If the cost of a customizing job was \$24,000, and the shop received \$30,000 for the job, what was the percentage of profit?

TEST

25. Solve the following basic ratio and proportion problems. Write your answers in the blanks.

- _____ a. Convert the ratio 0.5:0.5:2 to the smallest whole-number proportion.
- _____ b. Convert the ratio 1:1:3 to a decimal proportion.
- _____ c. What would be the proportion if a mix of 2.5:2.5:5 were doubled?
- _____ d. What would be the proportion if a 3:3:12 mix were cut to one-third?
- _____ e. If a mixture of 2 parts reducer, 4 parts pigment, and 6 parts enamel were needed to do a job, what would the proportion be?
- f. Referring to problem e, how many ounces of each proportion would it take to make 36 ounces of mix?

Ounces of reducer = _____

Ounces of pigment = _____

Ounces of enamel = _____

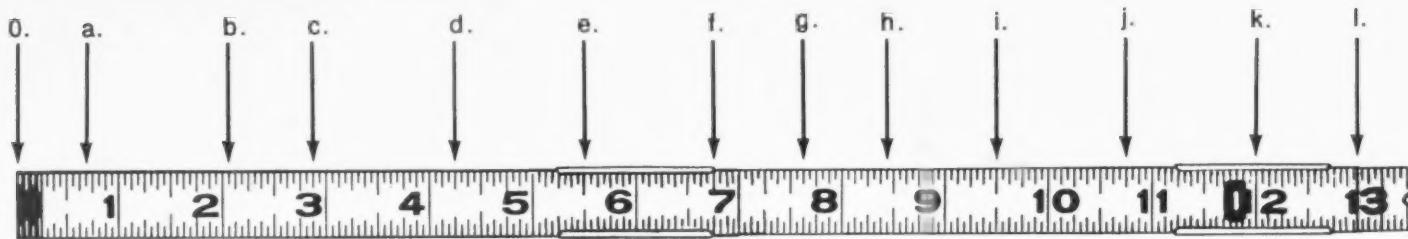
26. Identify graduations on the rule illustrated below. Write the correct names in the blanks.



- | | |
|----------|----------|
| a. _____ | b. _____ |
| c. _____ | d. _____ |
| e. _____ | f. _____ |

TEST

27. Read the rule illustrated below to the nearest fraction of an inch. Start each reading from the 0 end of the rule. Write the correct graduations in the corresponding blanks.



- | | |
|----------|----------|
| a. _____ | b. _____ |
| c. _____ | d. _____ |
| e. _____ | f. _____ |
| g. _____ | h. _____ |
| i. _____ | j. _____ |
| k. _____ | l. _____ |

MATH AND MEASURING
UNIT IV

ANSWERS TO TEST

1. a. 5 g. 2
b. 10 h. 11
c. 1 i. 8
d. 9 j. 7
e. 6 k. 3
f. 4
2. a. 5 f. 3
b. 7 g. 8
c. 1 h. 2
d. 10 i. 6
e. 9 j. 4
3. a. Millions
b. Hundred thousands
c. Ten thousands
d. Thousands
e. Hundreds
f. Tens
g. Units
4. a. 11
b. 20
c. 128
d. 1797
e. 21,085
5. a. 2
b. 26
c. 402
d. 342
e. 1119
6. a. 35
b. 612
c. 49,980
d. 348,513
e. 5,568,066
7. a. 12
b. 4
c. 16
d. 2
e. 14, R 131
f. 152, R 400
8. a. P f. P
b. M g. P
c. I h. M
d. M i. P
e. M j. I
9. a. $\frac{1}{2}$ f. $\frac{1}{4}$
b. $\frac{1}{2}$ g. $\frac{1}{8}$
c. $\frac{7}{16}$ h. $\frac{1}{8}$
d. $\frac{1}{4}$ i. $\frac{3}{4}$
e. $\frac{3}{8}$ j. $3\frac{1}{32}$
10. a. $\frac{7}{2}$
b. $\frac{9}{2}$
c. $\frac{15}{4}$
d. $\frac{25}{2}$
e. $42\frac{9}{32}$
11. a. $5\frac{7}{8}$
b. $2\frac{1}{3}$
c. $4\frac{16}{23}$
d. $10\frac{4}{5}$
e. 16
12. a. $\frac{3}{4}$ f. $1\frac{1}{4}$
b. 1 g. $9\frac{3}{8}$
c. $1\frac{1}{4}$ h. $19\frac{5}{8}$
d. 1 i. $12\frac{3}{4}$
e. 1 j. $11\frac{1}{4}$
13. a. $\frac{1}{8}$ f. 0
b. $\frac{1}{2}$ g. $1\frac{1}{2}$
c. $5\frac{1}{16}$ h. $3\frac{5}{8}$
d. $\frac{1}{8}$ i. 5
e. $\frac{1}{4}$ j. $5\frac{5}{8}$

ANSWERS TO TEST

14. a. $\frac{3}{8}$ e. $59\frac{1}{16}$ 21. a. 0.3333; 33% f. 0.2857; 29%
 b. $\frac{9}{32}$ f. $10\frac{1}{16}$ b. 0.12; 12% g. 8.00013; 800%
 c. $\frac{3}{32}$ g. $24\frac{1}{16}$ c. 23.03; 2303% h. 0.8333; 83%
 d. $47\frac{1}{8}$ e. 0.4375; 44% d. 11.000024; 1100%
 i. 18.3; 1830%
 j. 5.005; 501%
15. a. $3\frac{1}{2}$ e. $9\frac{1}{6}$ 22. a. $\frac{1}{8}$ e. 6.25
 b. $17\frac{1}{22}$ f. $19\frac{1}{16}$ b. .25 f. $\frac{3}{4}$
 c. 81 g. $6\frac{2}{3}$ c. $\frac{3}{8}$ g. .875
 d. $14\frac{1}{5}$ h. $1\frac{1}{2}$ d. .5 h. 1
16. a. Tenths
 b. Hundredths
 c. Thousandths
 d. Ten thousandths
 e. Hundred thousandths
 f. Millionths
17. a. 15.6
 b. 5.346
 c. \$20.63
 d. 132.003
 e. 6735.2613
18. a. \$3.90
 b. \$3.08
 c. \$6.75
 d. 0.585325
 e. 0.25
19. a. 12.22
 b. 0.00595
 c. 0.72
 d. 680.58144
 e. 7.22
20. a. 13.3 f. 120
 b. 139 g. 600
 c. 31 h. 9000
 d. 3.07 i. 14,000
 e. 0.15 j. 105,375
23. a. 0.12; $\frac{3}{25}$
 b. 0.30; $\frac{3}{10}$
 c. 0.45; $\frac{9}{20}$
 d. 0.72; $\frac{18}{25}$
 e. 2.50; $2\frac{1}{2}$
24. a. \$22.41
 b. 1848 gallons
 c. 20 percent
25. a. 1:1:4
 b. 0.33:0.33:1 or any other proportional decimal
 c. 5:5:10
 d. 1:1:4
 e. 2:4:6
 f. 6 ounces reducer, 12 ounces of pigment, 18 ounces of enamel
26. a. Thirty-seconds
 b. Sixteenths
 c. Eighths
 d. Inches
 e. Halves
 f. Quarters or fourths
27. a. $\frac{11}{16}$ " g. $7\frac{5}{8}$ "
 b. $2\frac{1}{16}$ " h. $8\frac{7}{16}$ "
 c. $2\frac{7}{8}$ " i. $9\frac{1}{2}$ "
 d. $4\frac{1}{4}$ " j. $10\frac{3}{4}$ "
 e. $5\frac{1}{2}$ " k. 12" or 1' - 0"
 f. $6\frac{3}{4}$ " l. 13" or 1' - 1"

INTERIOR DETAILING UNIT V

UNIT OBJECTIVE

After completing this unit, the student should be able to demonstrate the ability to restore an automobile interior to like-new appearance. The student will show this knowledge by completing the assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with interior detailing.
2. Select from a list businesses that employ interior detail personnel.
3. Match general types of materials used in interior detailing to specific places where each is used.
4. Match common spots, stains, and soils to cleaning materials or products recommended for their removal.
5. List safety precautions to observe when using volatile cleaners.
6. Demonstrate the ability to
 - a. Clean plain interior fabrics.
 - b. Clean coated interior fabrics, genuine leather, and molded plastic interior components.
 - c. Clean polyurethane foam interior components.
 - d. Clean painted interior surfaces.
 - e. Clean black rubber interior surfaces and weatherstripping.

INTERIOR DETAILING
UNIT V

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Information sheet
 - D. Assignment sheets
 - 1. Assignment Sheet #1 — Use a Stain and Spot Treatment Chart for Upholstered Trim Material
 - 2. Assignment Sheet #2 — Match Common Spots, Stains, and Soils to Cleaning Materials or Products Recommended for Their Removal
 - E. Answers to assignment sheets
 - F. Job sheets
 - 1. Job Sheet #1 — Clean Plain Interior Fabrics
 - 2. Job Sheet #2 — Clean Coated Interior Fabrics, Genuine Leather, and Molded Plastic Interior Components
 - 3. Job Sheet #3 — Clean Polyurethane Foam Interior Components
 - 4. Job Sheet #4 — Clean Painted Interior Surfaces
 - 5. Job Sheet #5 — Clean Black Rubber Interior Surfaces and Weatherstripping
 - G. Test
 - H. Answers to test
- II. Instructor's guide
 - A. Review unit and plan presentation.
 - B. Obtain materials to supplement unit.
 - 1. Materials and equipment listed in job sheets
 - 2. Samples of various materials used in auto interiors

SUGGESTED ACTIVITIES

(NOTE: Obtain these samples from a local auto upholstery shop.)

3. Samples of different kinds of soaps and cleaners used for interior detailing
4. Cleaning charts such as that in Assignment Sheet #1
5. Competency profiles

(NOTE: Competency profiles are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Ask students if they are familiar with the services offered by an automotive detail shop.
- Check with a local detail shop about services offered and prices. Relate this information to students.
- Explain that most customers expect a thorough repair job and are impressed when a repaired vehicle is returned with like-new interior trim.

E. Discuss unit and specific objectives.

F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions.

SUGGESTIONS:

- Explain that the use of appropriate terms for one's trade not only improves professionalism but also makes communication with others easier.
 - Show students examples of appropriate terms.
2. Use Information Sheet, Section II to discuss businesses that employ interior detail personnel.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Ask students if anyone in the class has worked as a detail person. If there is such a student, have her or him explain how the job was obtained and on-the-job duties.
 - Plan a field trip to a business that does detail work.
3. Use Information Sheet, Section III to discuss types of materials used in interior detailing and specific places where each is used.

SUGGESTIONS:

- Show the class samples of the various fabrics and materials used in interior detailing.
 - Prepare a bulletin board display of various fabrics and materials used in interior detailing.
 - Plan a field trip to an automotive upholstery shop.
 - Explain that it is important for technicians to be able to recognize the various types of materials so that they may perform the correct cleaning procedures.
4. Use Information Sheet, Section IV to discuss common spots, stains, and soils and the cleaning materials or products recommended for their removal.

SUGGESTIONS:

- Prepare a display containing samples of various cleaning materials and products.
- Prepare a bulletin board with cleaning charts obtained from upholstery shops and automotive shops.
- Write the following cleaning sequence on the chalkboard. Explain that such a cleaning sequence should be developed and followed.
 - a. Doorjambs, including weatherstripping
 - b. Headliner and visor
 - c. Instrument panel group
 - d. Package tray (parcel shelf)
 - e. Seats

SUGGESTED ACTIVITIES

- f. Trim panels
- g. Floor coverings (carpet)
- h. Windows
- Explain that it is generally best to work from top to bottom and from inside out to avoid getting soil on parts previously cleaned.
- Have students complete Assignment Sheets #1 and #2.
- 5. Use Information Sheet, Section V to discuss safety precautions to follow when using volatile liquids.

SUGGESTIONS:

- Have students to respond to "What would happen if . . . ?" questions.
- Discuss any case studies, newspaper articles, or personal experiences related to improper handling of volatile liquids.
- Demonstrate procedures outlined in Job Sheets #1 through #5.
- Have students complete Job Sheets #1 through #5.

G. Give test.

H. Critique test and discuss in class.

I. Reteach and retest if necessary.

J. Complete appropriate section of competency profiles.

III. Unit references

- A. Sharpton, James. *Cleaning Services*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1982.
- B. Tobolt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1972.

INTERIOR DETAILING
UNIT V

INFORMATION SHEET

I. Terms and definitions

- A. Detailing — Restoring an automobile to like-new appearance by cleaning, repairing, refinishing, and replacing components
- B. Components — Parts or units that may be bolted or welded together to form an assembly or group
- C. Group (assembly) — Two or more components fastened together to form one unit

EXAMPLE: An instrument panel becomes a group or assembly when radio, glove compartment and door, heater and air conditioner controls, speedometer, gauges, and crash pad and are bolted in place.

- D. Package tray (parcel shelf) — Area located between rear seat backrest and rear window on passenger cars; provides mounting space for rear speakers
- E. Interior — Inner surface surrounding passenger compartment; provides style and comfort for passengers and also serves as a sound-deadener and weather barrier
- F. Trim material — Fabric or other material used to make seats, carpeting, trim panels, and other components that make up the interior of an automobile
- G. Plain fabric — Cloth used for seat and trim panel inserts

EXAMPLES: Gabardine, broadcloth, velour

- H. Coated fabric — Vinyl-covered or nylon-covered cloth widely used by automobile manufacturers for seats, trim panels, roof coverings, carpeting, and other items
- I. Volatile cleaner — Colorless, fast-evaporating, highly flammable liquid manufactured and distributed for the purpose of removing grease, oil, tar, and other spots from fabrics, including interior upholstery
- J. Neutral soap — Mild liquid or solid cleaner that does not contain harsh additives such as bleach

EXAMPLES: Saddle soap, dishwashing liquids

INFORMATION SHEET

II. Businesses that employ interior detail personnel

A. New automobile and truck dealerships

EXAMPLES: New car clean-up, used car trade-ins, body-shop work

B. Used automobile and truck dealerships

C. Automobile rental agencies

D. Independent body shops

E. Large businesses with motor pools

III. Specific places where types of materials used in interior detailing may be used

A. Plain fabrics — Complete seat coverings, seat inserts, trim panel inserts, headliners

EXAMPLES: Velour, gabardine

B. Coated fabrics — Complete seat coverings, seat inserts, trim panel inserts, headliners, floor carpeting

EXAMPLES: Nylon, simulated-leather vinyl

C. Molded plastics — Instrument panel components, kick panels, trim panel components, garnish moldings

D. Genuine leather — Complete seat coverings in some luxury models and expensive imports

E. Polyurethane foam — Headliners in some luxury models

F. Painted surfaces — Instrument panel shells and steering columns on all models and trucks; garnish moldings on some models

G. Black rubber — Floor mats in some economical models, some trucks, and some imports; brake and accelerator pedals for all models and trucks; inside door and window handle knobs on some imports

IV. Cleaning materials or products recommended for removal of common spots, stains, and soils

A. Normal soil

1. Plain fabric — Solution of synthetic detergent and lukewarm water

2. Coated fabric and genuine leather — Solution of mild, neutral soap and lukewarm water

INFORMATION SHEET

3. Polyurethane foam — Solution of white detergent powder and water
4. Molded plastic
 - a. Any type of automotive or household detergent and lukewarm water
 - b. Commercial cleaner or vinyl upholstery cleaner designed specifically for use on automotive interiors

B. Grease, oil, and tar—Volatile cleaner

(NOTE: When using volatile cleaners on fabric, do not use an excessive amount of cleaner. Use a minimum amount of pressure, and work from outer edge of spot toward center to prevent spreading dirt. Change cloths frequently.)

C. Blood

1. Cold, clean water

(NOTE: Never use hot water on blood stains. Hot water sets the stain and makes removal impossible.)

2. Ammonia if stain remains after spot dries

(NOTE: Let ammonia remain on the stain for a few minutes, and then wipe with a cloth and cold water.)

D. Chewing gum — Ice cube and dull knife

(NOTE: Hold ice cube on gum to harden it and then scrape surface with dull knife. Any remaining residue can be removed with volatile cleaner and a clean cloth.)

E. Shoe polish

1. Liquid — Brush
2. Paste or wax — Volatile cleaner

F. Candy

1. Nonchocolate — Hot water followed by a volatile cleaner
2. Chocolate
 - a. Warm, mild soapsuds followed by scraping with a dull knife
 - b. Cold water rinse
 - c. Volatile cleaner if stain remains after spot dries

INFORMATION SHEET

- V. Safety precautions to observe when using volatile cleaners
 - A. Work outdoors when possible
 - B. Use volatile cleaners indoors only with adequate ventilation
 - C. Avoid prolonged contact of volatile cleaner with skin
 - D. Keep volatile cleaners away from eyes and mouth
 - E. Make sure that no sparks or open flame is present when using volatile cleaners
 - F. *Do not* use electrical equipment when volatile cleaners are being used

INTERIOR DETAILING
UNIT VASSIGNMENT SHEET #1 — USE A STAIN AND SPOT TREATMENT
CHART FOR UPHOLSTERED TRIM MATERIAL

NAME _____ SCORE _____

To prevent or lessen permanent staining or damage to upholstery, quick and correct treatment is needed. Because of the many types of stain-causing items, it is hard to remember the correct spot treatment for each. Therefore, a technician needs to know how to use a stain and spot removal chart.

Select five stains from the following chart, one for each of the five spot-cleaning methods. Write below the spot-cleaning methods for each stain.

- A. _____

- B. _____

- C. _____

- D. _____

- E. _____

ASSIGNMENT SHEET #1

Alcohol, beer, mixed drinks	.1	Milk, cream, ice cream	.1
Blood	.1	Mud	.4
Butter, margarine	.1	Mustard	.1, 2
Candy, other than chocolate	.1	Nail polish	.4
Catsup, tomato juice	.1	Oil, clear vegetable	.1
Chocolate, cocoa	.1	Oil, machine, mineral	.2
Cigarette burns	.4	Paint, water base, wet	.1
Coffee, black	.1	Paint, oil base, wet	.4
Coffee, with cream	.1	Paint, dry	.5
Coffee, with sugar	.1	Peanut butter	.1
Correction fluid	.2, 5	Perfume	.3
Cosmetics	.2	Rust	.1, 5
Egg	.1	Sauces, salad dressing	.1
Fruit, berry stains	.1	Shoe polish	.2
Grease	.2	Soft drinks	.1
Glue, household	.1	Sugar, jelly, jam, syrup	.1, 2
Glue, model	.4	Tar, asphalt	.2
Gravy	.1, 2	Tea	.1
Gum	.4	Toothpaste	.1
Ink, ballpoint	.2	Urine	.4
Ink, nonwater-soluble	.2, 5	Vomit	.1
Ink, water-soluble	.1	Water	.4
Iodine	.5	Wax, candle	.4
Lipstick	.2	Wax, car, floor, furniture	.2
Mercurochrome, Merthiolate	.3	Wine	.1
Mildew	.1, 5		

CLEANING METHOD #1 — Foodstuff, starches, and sugars. Remove excess material by blotting up liquids with a clean absorbent towel and scraping up solids with the dull edge of a knife. Sponge lightly with cool water and blot several times. Apply carpet shampoo (diluted, 1 part liquid carpet shampoo to 4 parts water) with a brush or turkish towel. Let the area dry thoroughly, then vacuum. Repeat if necessary.

CLEANING METHOD #2 — Oily materials and grease. Remove excess material by blotting up liquids with a clean absorbent towel and scraping up solids with the dull edge of a knife. Apply a spot cleaner or dry-cleaning solvent according to product directions. (Some spot cleaners dry to a powder. If this type is used, vacuum before continuing.) Apply carpet shampoo (diluted, 1 part liquid carpet shampoo to 4 parts water) with a brush or turkish towel. Let the area dry thoroughly, then vacuum. Repeat if necessary.

CLEANING METHOD #3 — Alcohol-based antiseptics and perfume. Remove excess material by blotting up liquids with a clean absorbent towel and scraping up solids with the dull edge of a knife. Sponge with alcohol (or a dilution of alcohol and water) and blot quickly. Repeat several times until no more stain color is absorbed into the towel. Apply carpet shampoo (diluted, 1 part liquid shampoo to 4 parts water) with a brush or turkish towel. Let area dry thoroughly, then vacuum.

CLEANING METHOD #4 — Special treatment. Be sure to pretest all solvents recommended.

Cigarette burns — For light burns, brush area lightly and then carefully clip away charred tufts. Shampoo. Severe burns will require repair or replacement of affected material.

Glue, model — After removing excess, carefully apply nail-polish remover by drops to soften glue. Scrape or blot away. Shampoo, let dry, and vacuum. Remember to pretest nail-polish remover as it may affect some synthetic fibers.

ASSIGNMENT SHEET #1

Gum — After removing as much as possible by scraping, "freeze" the residue with ice cubes in a plastic bag. Break or scrape off brittle gum. Shampoo, let dry, then vacuum.

Mud — Scrape up as much wet mud as possible and allow residue to dry completely. Vacuum well and then shampoo. Let area dry and vacuum again.

Nail polish — After removing excess, apply nail-polish remover by drops to soften; then blot or scrape away. Shampoo, let dry, then vacuum. Remember to pretest nail-polish remover as it may affect some synthetic carpet fibers.

Paint, oil base, wet — After removing excess paint, carefully apply turpentine or paint thinner and blot repeatedly. Shampoo, let dry, then vacuum.

Urine — Blot up excess with clean towel. Sponge with cool water and blot. Then sponge with white vinegar and blot well. Shampoo, let dry, then vacuum.

Water — For severe wetting, mop or blot as much as possible. Dry material quickly to prevent rot or mildew. Once dry, shampoo lightly, let dry, then vacuum.

Wax, candle — Remove excess by scraping. Cover with several layers of paper towel and press lightly with a warm iron until all wax is removed. Be careful not to melt fibers with iron. Shampoo, let dry, then vacuum.

CLEANING METHOD #5 — Follow advice of a commercial carpet and rug cleaning service.

INTERIOR DETAILING UNIT V

ASSIGNMENT SHEET #2 — MATCH COMMON SPOTS, STAINS, AND SOILS TO CLEANING MATERIALS OR PRODUCTS RECOMMENDED FOR THEIR REMOVAL

NAME _____

SCORE _____

Auto-body technicians are often confronted with various spots, stains, and soils when detailing customers' automobiles. The specific removal procedures are as numerous as the number of problems encountered. Out of necessity, a technician needs to become familiar with a few basic procedures for removing some of the more common spots, stains, and soils.

Match the following spots, stains, or soils to the cleaning materials or products recommended for their removal. Write the correct numbers in the blanks. Some blanks may contain more than one number.

- | | | |
|---------|--|---|
| _____A. | Volatile cleaner | 1. Normal soil, plain fabric |
| _____B. | Cold clean water; ammonia if stain remains after spot dries | 2. Normal soil, coated fabric and genuine leather |
| _____C. | Ice cube and dull knife | 3. Normal soil, molded plastic |
| _____D. | Brush | 4. Normal soil, polyurethane foam |
| _____E. | Solution of synthetic detergent and lukewarm water | 5. Grease, oil, tar |
| _____F. | Hot water followed by volatile cleaner | 6. Blood |
| _____G. | Warm, mild soapsuds followed by scraping with a dull knife; cold water rinse; volatile cleaner if stain remains after spot dries | 7. Chewing gum |
| _____H. | Solution of mild, neutral soap and lukewarm water | 8. Paste or wax shoe polish |
| _____I. | Solution of white detergent powder and water | 9. Chocolate candy |
| _____J. | Any type of automotive or household detergent and lukewarm water; commercial cleaner or vinyl upholstery cleaner designed specifically for use on automotive interiors | 10. Nonchocolate candy |
| | | 11. Liquid shoe polish |

INTERIOR DETAILING
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — Evaluated to the satisfaction of the instructor

Assignment Sheet #2

- A. 5, 8
- B. 6
- C. 7
- D. 11
- E. 1
- F. 10
- G. 9
- H. 2
- I. 4
- J. 3

INTERIOR DETAILING
UNIT V

JOB SHEET #1 — CLEAN PLAIN INTERIOR FABRICS

I. Equipment and materials

- A. Vacuum cleaner
- B. Two buckets
- C. Clean, soft, absorbent rags
- D. Cellulose sponge
- E. Synthetic detergent
- F. Household ammonia
- G. Lukewarm water
- H. Manila-bristled upholstery brush
- I. Rubber gloves

II. Procedure

- A. Vacuum loose dust and dirt from fabric

(NOTE: In some cases, vacuum cleaning is all that is necessary. However, if material is still soiled, the following steps and procedures should be used.)

- B. Put on rubber gloves
- C. Make solution of approximately 4 tablespoons detergent and 1 tablespoon ammonia to approximately 1½ gallons clean, lukewarm water
- D. Apply solution to surface of fabric with brush, using light pressure and small, circular motions
 - 1. Spread solution evenly and work suds into fabric to loosen soil
 - 2. Cover only a small area at one time so that dirt can be removed before surface begins to dry or solution sinks farther into fabric
- E. Remove dirt and excess suds by rubbing area with a clean rag or cellulose sponge dampened with clean, warm water

(NOTE: The best results can be obtained by pulling soapsuds and dirt from the surface with a wet-type vacuum cleaner if one is available.)

JOB SHEET #1

- F. Repeat procedure until you have cleaned the fabric on the component you are detailing

(NOTE: Seats and carpets are usually cleaned in two operations, left side and right side. Always work from inside to outside and from top to bottom.)

- G. Rub section or component with soft, clean, absorbent cloth; use firm pressure to remove additional dirt and moisture and to speed drying time

(NOTE: This step should be done even if a wet vacuum cleaner was used.)

- H. Allow fabric to dry

- I. Repeat the cleaning operation if necessary

- J. Clean work area and put away equipment and materials

INTERIOR DETAILING
UNIT V

JOB SHEET #2 — CLEAN COATED INTERIOR FABRICS, GENUINE LEATHER,
AND MOLDED PLASTIC INTERIOR COMPONENTS

I. Equipment and materials

- A. Two buckets
- B. Two cellulose sponges
- C. Lukewarm water
- D. Neutral soap
- E. Clean, soft, absorbent rags
- F. Furniture dusting polish (optional)
- G. Rubber gloves

II. Procedure

CAUTION

Never use harsh cleaners or abrasive materials on coated fabrics, genuine leather, or molded plastics, especially on instrument panel components. Trim with chrome appearance will be permanently damaged and cannot be repaired.

- A. Put on rubber gloves
- B. Mix thick suds by dissolving approximately 2 ounces of neutral soap in enough clean, lukewarm water to make suds
- C. Apply suds to surface of component with sponge

(NOTE: Squeeze excess water from sponge before applying to surface. Do not flood surface, especially if cleaning near speakers in package tray or instrument panel.)
- D. Before soap dries, remove all traces of suds with a second sponge dampened with clean, warm water
- E. Wipe immediately with clean, dry, soft cloth, taking care to wipe out cracks and crevices around moldings and in grooves
- F. Repeat cleaning operation if necessary
- G. After surface is clean and dry, spray it with furniture dusting polish and then wipe it dry with soft, clean cloth

JOB SHEET #2

(NOTE: Furniture dusting polish will not harm the material and is a good method for maintaining good appearance if used at regular intervals.)

H. Clean work area and put away equipment and materials

INTERIOR DETAILING
UNIT V

JOB SHEET #3 — CLEAN POLYURETHANE FOAM INTERIOR COMPONENTS

- I. Equipment and materials
 - A. Two buckets
 - B. Warm water
 - C. White powdered detergent
 - D. Two cellulose sponges
 - E. Rubber gloves

- II. Procedure

CAUTION

Polyurethane foam is a very delicate material used in some models for headliners. It should be cleaned with care to avoid permanent damage. Do not use a whisk broom or vacuum cleaner on polyurethane foam.

- A. Put on rubber gloves
- B. Mix approximately 2 ounces of white, powdered detergent in 1 gallon of clean, warm water
- C. Immerse clean cellulose sponge in the solution; wring out all excess water, leaving only suds on sponge
- D. Using light pressure, apply suds to a section of polyurethane surface
(NOTE: Do not try to clean entire surface of component in one operation.)
- E. Rinse with a second sponge immersed in clean water, squeezing excess water from sponge before rinsing

CAUTION

Squeeze excess water from sponge before applications. Do not soak surface.

- F. Repeat cleaning and rinsing procedure until polyurethane foam component is clean
- G. If necessary, repeat cleaning procedure after surface has dried
- H. Clean work area and put away equipment and materials

INTERIOR DETAILING
UNIT V

JOB SHEET #4 — CLEAN PAINTED INTERIOR SURFACES

I. Equipment and materials

- A. Two buckets
- B. Two cellulose sponges
- C. Warm water
- D. Clean, soft rags
- E. Neutral soap
- F. Furniture dusting polish (optional)
- G. Rubber gloves

II. Procedure

(NOTE: Painted surfaces are usually found on parts of the instrument panel and steering column. Interior finishes are usually low gloss; therefore, abrasive exterior polishes and waxes should never be used.)

- A. Put on rubber gloves
- B. Mix a solution of neutral soap and warm water
- C. Using light pressure, apply solution to surface of component with sponge
(NOTE: Squeeze excess water from sponge before applications.)
- D. Rinse before suds solution dries by wiping with a sponge dampened with clean water
- E. Wipe surface dry immediately with clean, soft, dry cloth
- F. Repeat procedure, cleaning component in small sections until interior surface is clean
- G. When surface is clean and dry, spray surface with light coat of furniture dusting polish, and wipe dry immediately

(NOTE: In cases where painted surface is glossy, as in truck interior instrument panels and around door jambs, exterior wax is recommended to clean and improve gloss.)

- H. Clean work area and put away equipment and materials

INTERIOR DETAILING
UNIT V

JOB SHEET #5 — CLEAN BLACK RUBBER INTERIOR
SURFACES AND WEATHERSTRIPPING

I. Equipment and materials

- A. Volatile cleaner
- B. Clean rags
- C. Rubber and vinyl cleaner
- D. Rubber gloves

II. Procedure

(NOTE: The following procedure is for small rubber parts such as brakes, accelerator pedals, and door handles. This system will also work for weatherstripping.)

- A. Put on rubber gloves
- B. Move vehicle to an outdoor location
- C. Saturate rag with volatile cleaner and wipe the rubber component

(NOTE: This method will clean residue from surface and give a like-new appearance.)

- D. Saturate a small piece of cloth with rubber or vinyl cleaner and wipe over rubber surface previously cleaned

(NOTE: Commercial cleaners will help make surfaces look like new. For best results, be sure to follow manufacturer's instructions on the container.)

- E. Continue this process until all black rubber surfaces are clean
- F. Clean work area and put away equipment and materials

INTERIOR DETAILING UNIT V

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with interior detailing. Write the correct numbers in the blanks.

- | | |
|---|--------------------------------|
| _____a. Mild liquid or solid cleaner that does not contain harsh additives such as bleach | 1. Group (assembly) |
| _____b. Colorless, fast-evaporating, highly flammable liquid manufactured and distributed for the purpose of removing grease, oil, tar, and other spots from fabrics, including interior upholstery | 2. Detailing |
| _____c. Fabric or other material used to make seats, carpeting, trim panels, and other components that make up the interior of an automobile | 3. Interior |
| _____d. Inner surface surrounding passenger compartment; provides style and comfort for passengers and also serves as a sound-deadener and weather barrier | 4. Coated fabric |
| _____e. Parts or units that may be bolted or welded together to form an assembly or group | 5. Trim material |
| _____f. Restoring an automobile to like-new appearance by cleaning, repairing, refinishing, and replacing components | 6. Volatile cleaner |
| _____g. Area located between rear seat backrest and rear window on passenger cars; provides mounting space for rear speakers | 7. Neutral soap |
| _____h. Cloth used for seat and trim panel inserts | 8. Components |
| _____i. Two or more components fastened together to form one unit | 9. Package tray (parcel shelf) |
| _____j. Vinyl-covered or nylon-covered cloth widely used by automobile manufacturers for seats, trim panels, roof coverings, carpeting, and other items | 10. Plain fabric |

TEST

2. Select from the following list businesses that employ interior detail personnel. Write an "X" in the blank before each correct answer.

- _____a. Automobile rental agencies
- _____b. Service stations
- _____c. New automobile and truck dealerships
- _____d. Large businesses with motor pools
- _____e. Upholstery shops
- _____f. Used automobile and truck dealerships
- _____g. Independent body shops
- _____h. Mechanic shops

3. Match general types of materials used in interior detailing to specific places where each is used. Write the correct numbers in the blanks.

- | | |
|--|----------------------|
| _____a. Complete seat coverings, seat inserts, trim panel inserts, headliners, floor carpeting | 1. Genuine leather |
| _____b. Complete seat coverings in some luxury models and expensive imports | 2. Painted surfaces |
| _____c. Complete seat coverings, seat inserts, trim panel inserts, headliners | 3. Molded plastics |
| _____d. Instrument panel shells and steering columns on all models and trucks; garnish moldings on some models | 4. Plain fabrics |
| _____e. Instrument panel components, kick panels, trim panel components, garnish moldings | 5. Black rubber |
| _____f. Headliners in some luxury models | 6. Coated fabrics |
| _____g. Floor mats in some economical models, some trucks, and some imports; brake and accelerator pedals for all models and trucks; inside door and window handle knobs on some imports | 7. Polyurethane foam |

TEST

4. Match common spots, stains, and soils to cleaning materials or products recommended for their removal. Write the correct numbers in the blanks. Some blanks may contain more than one answer.

_____a. Volatile cleaner	1. Normal soil, plain fabric
_____b. Ice cube and dull knife	2. Normal soil, coated fabric and genuine leather
_____c. Solution of white detergent powder and water	3. Normal soil, polyurethane foam
_____d. Cold, clean water; ammonia if stain remains after spot dries	4. Normal soil, molded plastic
_____e. Hot water followed by volatile cleaner	5. Grease, oil, tar
_____f. Warm, mild soapsuds followed by scraping with dull knife; cold water rinse; volatile cleaner if stain remains after spot dries	6. Blood
_____g. Brush	7. Chewing gum
_____h. Solution of synthetic detergent and lukewarm water	8. Paste or wax shoe polish
_____i. Solution of mild, neutral soap and lukewarm water	9. Nonchocolate candy
_____j. Any type of automotive or household detergent and lukewarm water; commercial cleaner or vinyl upholstery cleaner designed specifically for use on automotive interiors	10. Chocolate candy
	11. Liquid shoe polish

5. List four safety precautions to observe when using volatile cleaners.

- a. _____
- b. _____
- c. _____
- d. _____

TEST

(NOTE: Test question 6 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

6. Demonstrate the ability to
 - a. Clean plain interior fabrics.
 - b. Clean coated interior fabrics, genuine leather, and molded plastic interior components.
 - c. Clean polyurethane foam interior components.
 - d. Clean painted interior surfaces.
 - e. Clean black rubber interior surfaces and weatherstripping.

INTERIOR DETAILING
UNIT V

ANSWERS TO TEST

1.
 - a. 7
 - b. 6
 - c. 5
 - d. 3
 - e. 8
 - f. 2
 - g. 9
 - h. 10
 - i. 1
 - j. 4
2. a, c, d, f, g
3.
 - a. 6
 - b. 1
 - c. 4
 - d. 2
 - e. 3
 - f. 7
 - g. 5
4.

a. 5, 8	f. 10
b. 7	g. 11
c. 3	h. 1
d. 6	i. 2
e. 9	j. 4
5. Answer should include any four of the following
 - a. Work outdoors when possible
 - b. Use volatile cleaners indoors only with adequate ventilation
 - c. Avoid prolonged contact of volatile cleaner with skin
 - d. Keep volatile cleaner away from eyes and mouth
 - e. Make sure that no sparks or open flame is present when using volatile cleaners
 - f. *Do not* use electrical equipment when volatile cleaners are being used
6. Performance skills evaluated to the satisfaction of the instructor

BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

UNIT OBJECTIVE

After completing this unit, the student should be able to identify conventional and unitized body construction and the related parts of each. The student will show this knowledge by completing the assignment sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with automotive body and frame construction.
2. List major components of the front-end assembly.
3. Identify types of suspensions.
4. Identify front cowl panels.
5. Match door section components to their correct illustrations.
6. Label floor panel sections.
7. Match rocker panel and pillar components to their correct illustrations.
8. Match roof components to their correct illustrations.
9. Identify major components of the rear body assembly.
10. Name types of frame construction.
11. Use automotive reference texts and service manuals to identify body and frame components.

BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Transparency masters
 1. TM #1—Front Bumper
 2. TM #2—Front-End Assembly
 3. TM #3—Control-Arm-Type Front Suspension
 4. TM #4—MacPherson-Strut-Type Front Suspension
 5. TM #5—Floor Pan
 - D. Information sheet
 - E. Assignment Sheet #1—Use Automotive Reference Texts and Service Manuals to Identify Body and Frame Components
 - F. Answers to assignment sheet
 - G. Test
 - H. Answers to test
- II. Instructor's guide
 - A. Review unit and plan presentation.
 - B. Order or obtain materials to supplement unit.
 1. Films and filmstrips
 - a. *The Bodybuilders*, color, 26 minutes, 16 mm, General Motors, 1971. Available from General Motors Corp., 3044 West Grand Avenue, Detroit, Michigan 48238

(NOTE: Oklahoma teachers may order this film on a free-loan basis from the Media Resource Center, State Department of Education, 2500 North Lincoln Avenue, Oklahoma City, Oklahoma 73105. Out-of-state teachers must order from the address listed with the film.)

SUGGESTED ACTIVITIES

- b. *The G M MacPherson Strut System*, 3 cassettes, 3 filmstrips, instructor's guide; available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628

(NOTE: This series of filmstrips demonstrates the MacPherson strut suspension system with its coil spring and single, straight lower control arm. The filmstrip shows removal, disassembly, reassembly, and alignment of the front end.)

- c. *Body and Frame Construction*, 1 cassette, 1 filmstrip, 1 work sheet; available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628

2. Transparencies and competency profiles

(NOTE: Transparencies and competency profiles are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

3. Samples of spot welds
 4. Samples of fiberglass bonding
 5. Late-model automobile for demonstration purposes
 6. Collision estimating guides for each class member
 7. Samples of inner and outer panels from rear body assembly
 8. Discarded luggage lid
- C. Provide students with unit.
- D. Introduce unit.

SUGGESTIONS:

- Explain that *nomenclature* means the act or system of naming. Stress that for accurate repair, a technician must know the correct nomenclature for and understand the relationship between body and frame components.
 - Explain why body and frame dimensions must be within tolerance and symmetrical.
 - Show filmstrip *Body and Frame Construction*.
- E. Discuss unit and specific objectives. Explain to students that after completing this unit they should have a better understanding of automobile construction and frame and body nomenclature.

SUGGESTED ACTIVITIES

F. Discuss information and assignment sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with automotive body and frame construction.

SUGGESTIONS:

- Allow students a few minutes to review terms and definitions.
- Use a late-model automobile to point out various terms to students.
- Show film *The Bodybuilders*.
- Show samples of spot welds.
- Show samples of fiberglass bonding.

2. Use Information Sheet, Section II, and Transparencies #1 and #2 to illustrate front-end assembly panels and components.

SUGGESTIONS:

- Point out inner and outer panels on a late-model automobile.
- Explain the importance of inner panel strength and rigidity.
- Explain the purposes of style lines, flanges, and beads: strength, rigidity, appearance, aerodynamics, and fuel consumption.
- Demonstrate the oil-canning effect.
- Have students look up component parts and prices in collision estimating guides.

3. Use Information Sheet, Section III, and Transparencies #3 and #4 to illustrate and discuss types of suspensions.

SUGGESTIONS:

- Show filmstrip *The G M MacPherson Strut System*.
- Point out components on a late-model automobile.
- Explain the importance of correct alignment.
- Give examples of different tire wear patterns and their causes.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to discuss front cowl panels.

SUGGESTIONS:

- Point out components and how they are assembled on a late-model automobile.
- Point out fastening procedures and types of welds, such as a pinch weld.

5. Use Information Sheet, Section V to discuss door section components.

SUGGESTIONS:

- Point out components on a late-model automobile.
- Point out style lines, exterior trim, window frame, and molding.
- Discuss interior trim such as armrest base, armrest pad, and panel trim.
- Discuss hardware such as latch, striker, handle, hinge, and weatherstripping.
- Discuss glass and parts such as run channel, sealing strips, regulators, and vent glass.

6. Use Information Sheet, Section VI and Transparency #5 to discuss and illustrate floor panel sections.

SUGGESTIONS:

- Explain that floor panel sections are used as reference points after damage to make sure that the body and frame are square.
- Discuss the importance of learning correction shapes (box, tube, etc.) of metal components.

7. Use Information Sheet, Section VII to discuss rocker panel and pillar components.

SUGGESTIONS:

- Point out components on a late-model automobile.
- Show or explain the types of materials used on rocker panels and pillar components, and discuss their advantages and disadvantages.
- Have students look up component parts and prices in collision estimating guides.

SUGGESTED ACTIVITIES

8. Use Information Sheet, Section VIII to discuss roof components.

SUGGESTIONS:

- Point out components on a late-model automobile.
- Number the components on an automobile. Have students identify and record components.
- Have students look up component parts and prices in collision estimating guides.

9. Use Information Sheet, Section IX to discuss major components of the rear body assembly.

SUGGESTIONS:

- Point out areas of rigidity and weakness on sample panels.
- Let students touch and feel flexibility and rigidity of sample panel.
- Separate inner and outer panels on a discarded luggage lid for demonstration purposes.
- Point out inner and outer panels on a late-model automobile.
- Show or explain types of materials used for outer panels, and explain their advantages and disadvantages.

EXAMPLES: Fiberglass, aluminum, plastic, high-strength steel

10. Use Information Sheet, Section X, to discuss types of frame construction.

SUGGESTIONS:

- Explain that early frame strength came from the size and rigidity of the frame members. As automobile speeds increased, the need for a lower center of gravity necessitated design changes, and frames were then designed to flex.
- Explain that in unitized construction, strength and rigidity are designed into the shape of the body.
- Discuss the use of bolt-on stub frames to facilitate suspension and drive lines.

11. Have students complete Assignment Sheet #1 to help them identify components and learn body and frame nomenclature.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Make transparencies of Assignment Sheet #1 work sheets. After grading Assignment Sheet #1, follow up by discussing answers in class, utilizing these transparencies.
- Have students look up body parts in a collision estimating guide and record the prices.

G. Give test.

H. Critique test and discuss in class.

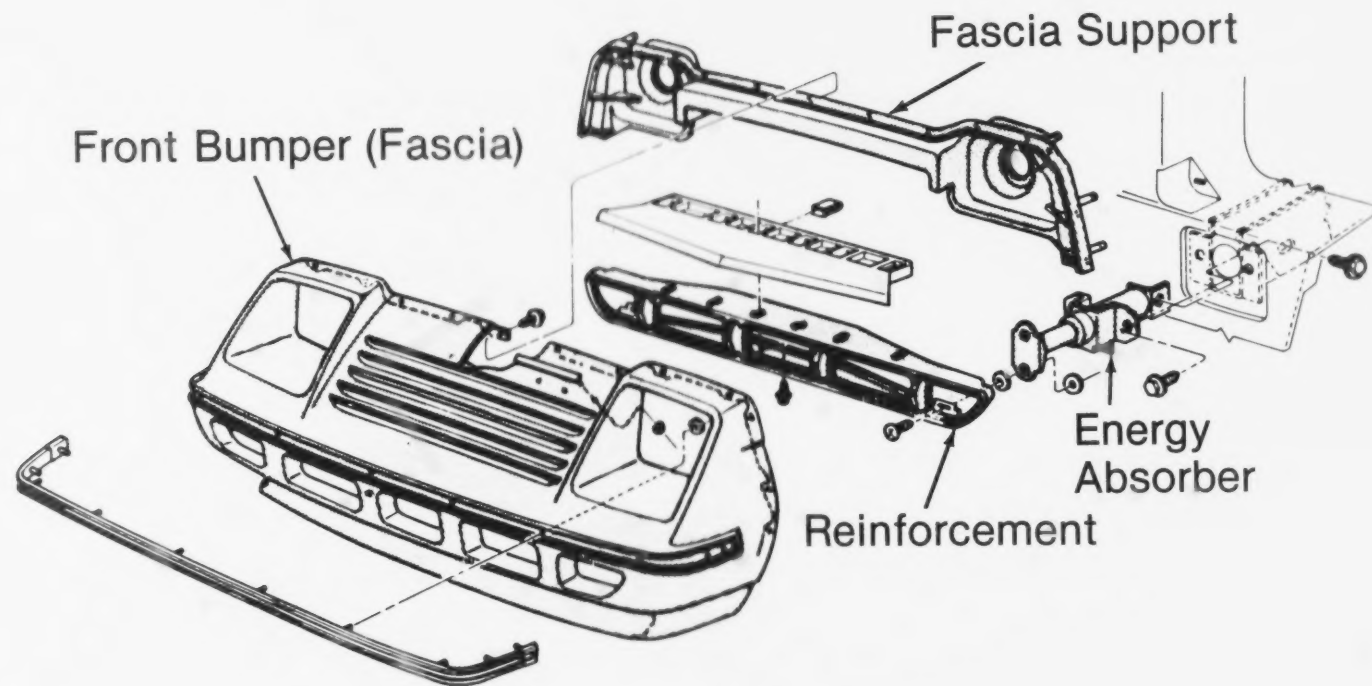
I. Reteach and retest if necessary.

J. Complete appropriate section of competency profiles.

III. Unit references

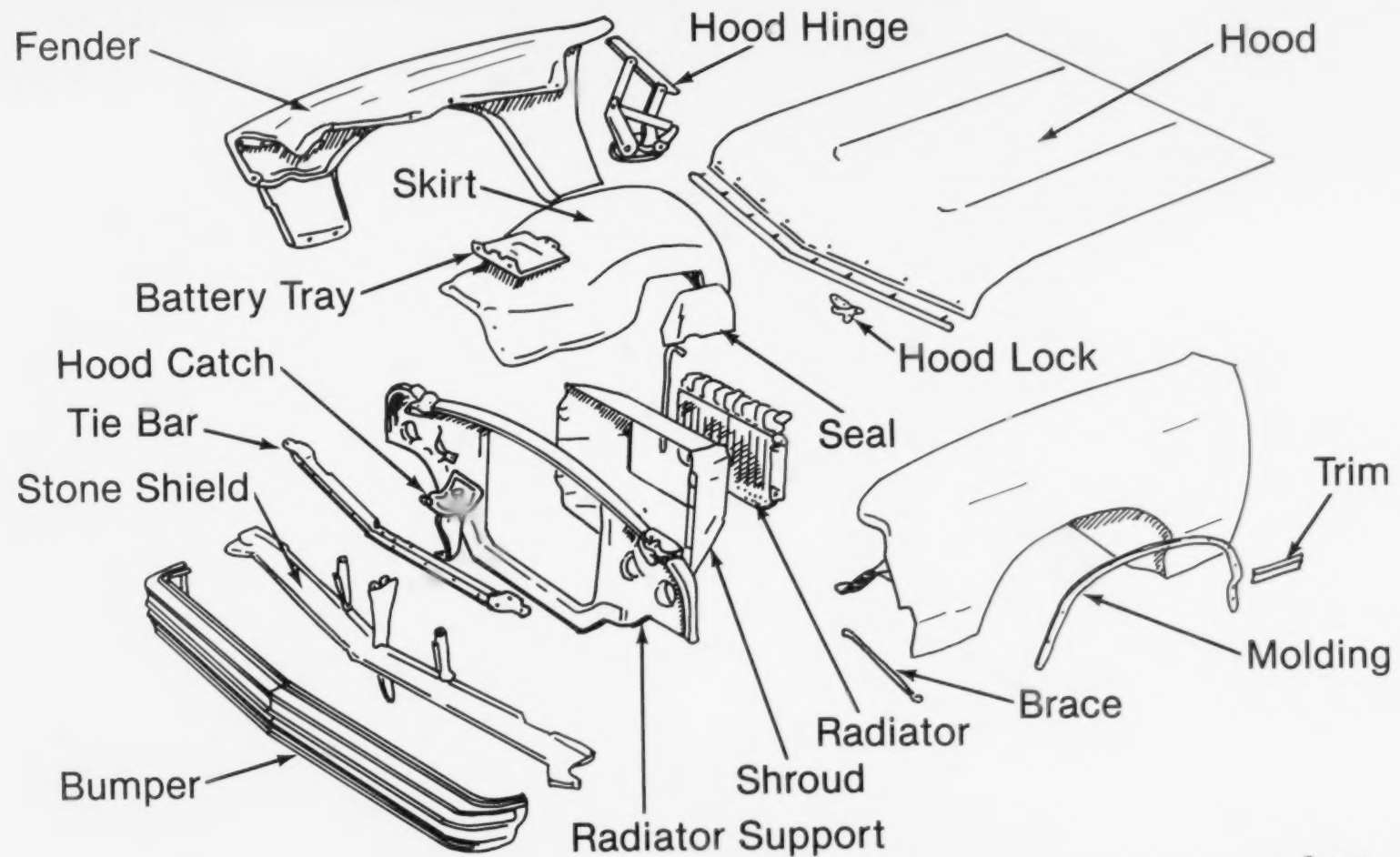
- A. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Company of Canada, Limited, 1969.
- B. *The Mitchell Collision-Estimating Guide: Domestic, Ford, Lincoln, Mercury*, Vol. 26, No. 4. San Diego, California: Mitchell Manuals, Inc., March, 1984.
- C. *Motor Crash Estimating Guide*, Vol. 16, No. 11. New York: The Hearst Corporation, August, 1984.
- D. *The New Science of Unibody Repair, Instructor Handbook*. Milwaukee, Wisconsin: Blackhawk, Applied Power Inc., Automotive Division, 1982.
- E. *1980 Service Manual Plymouth Horizon and Dodge Omni*. Detroit, Michigan: Chrysler Corporation, 1979.
- F. *1984 Chevrolet Shop Manual*, Detroit, Michigan: General Motors Corporation, 1984.
- G. *1979 Fisher Body Service Manual*, Detroit, Michigan: General Motors Corporation, 1978.
- H. Technical Service Bulletins, "Collision." San Diego, California: Mitchell Manuals, Inc., 1984.
- I. Toboldt, Bill. *Auto Body Repairing and Repainting*, 3rd. ed. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1972.

Front Bumper

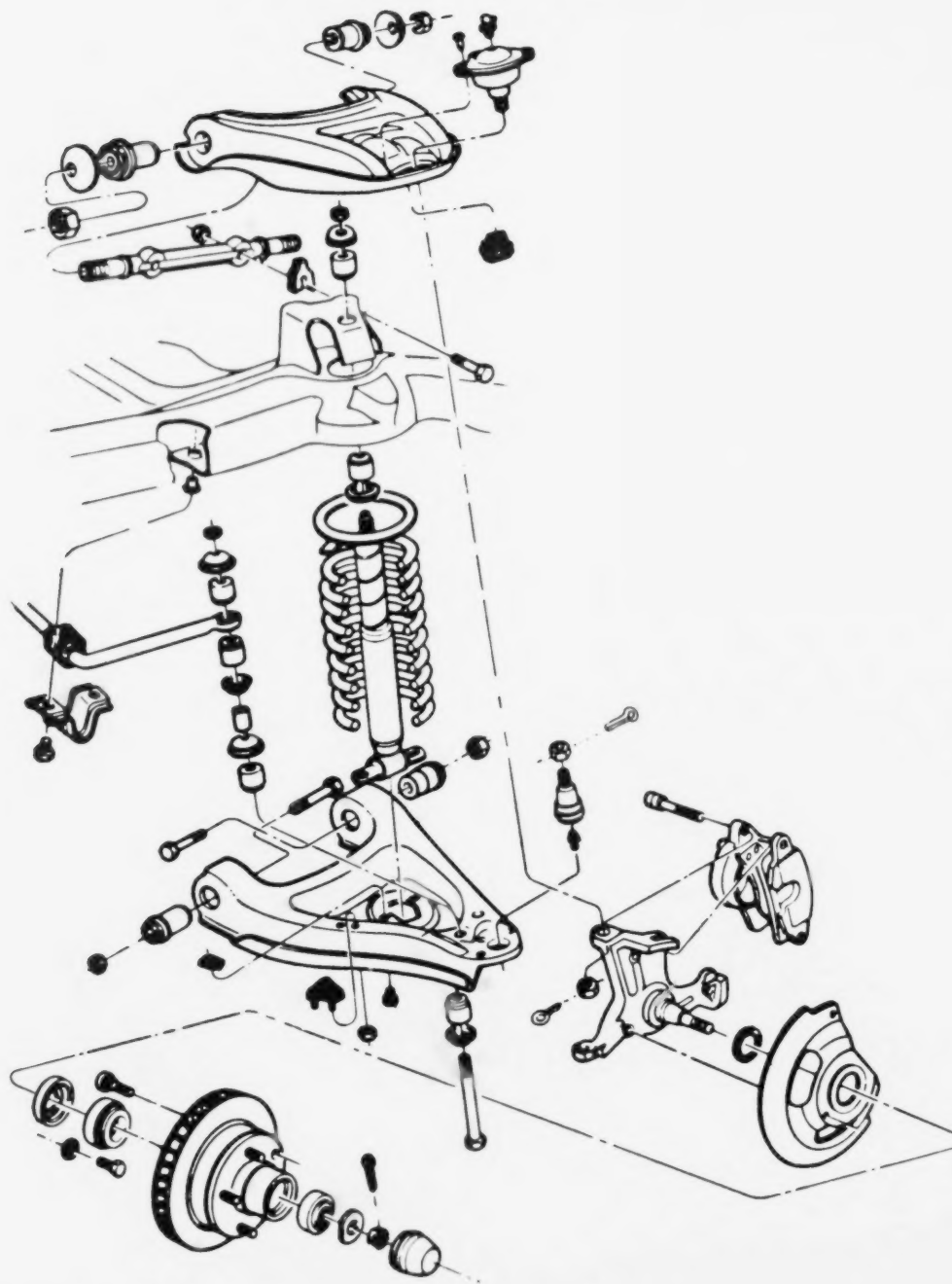


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Front-End Assembly

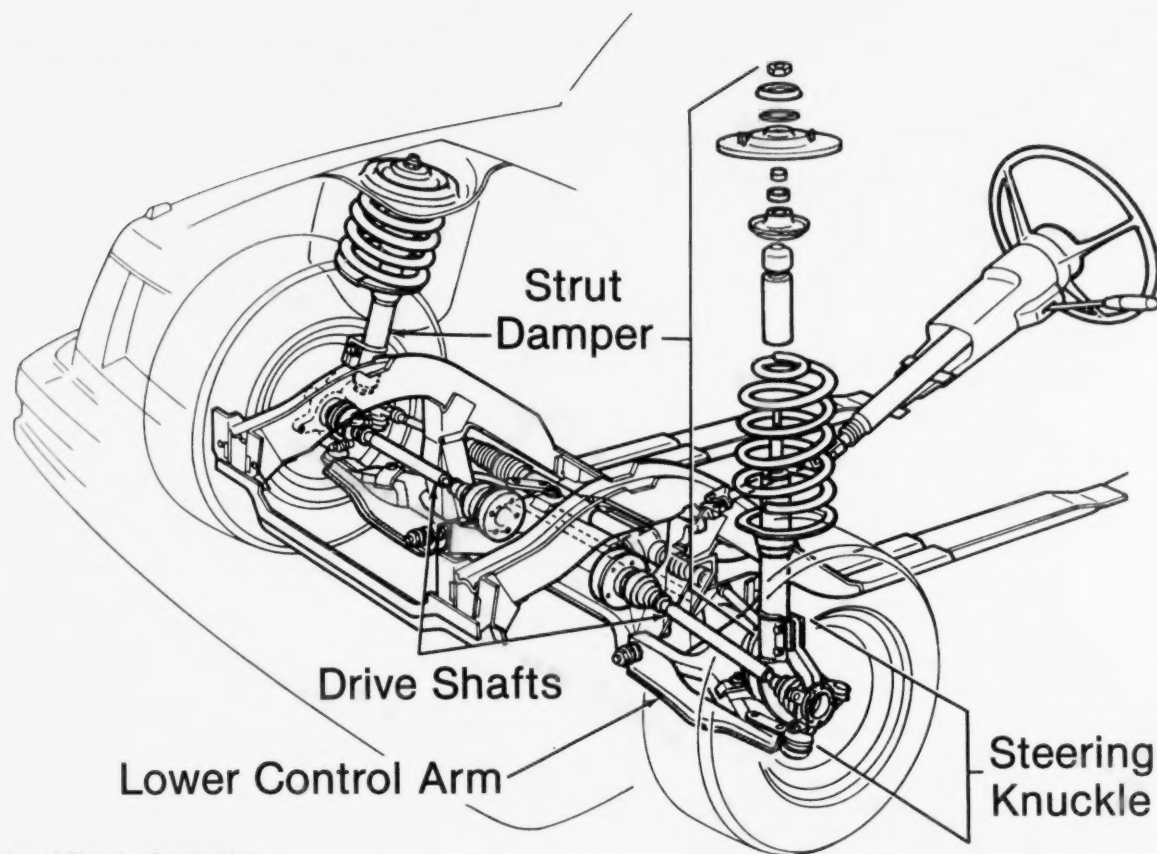


Control-Arm-Type Front Suspension



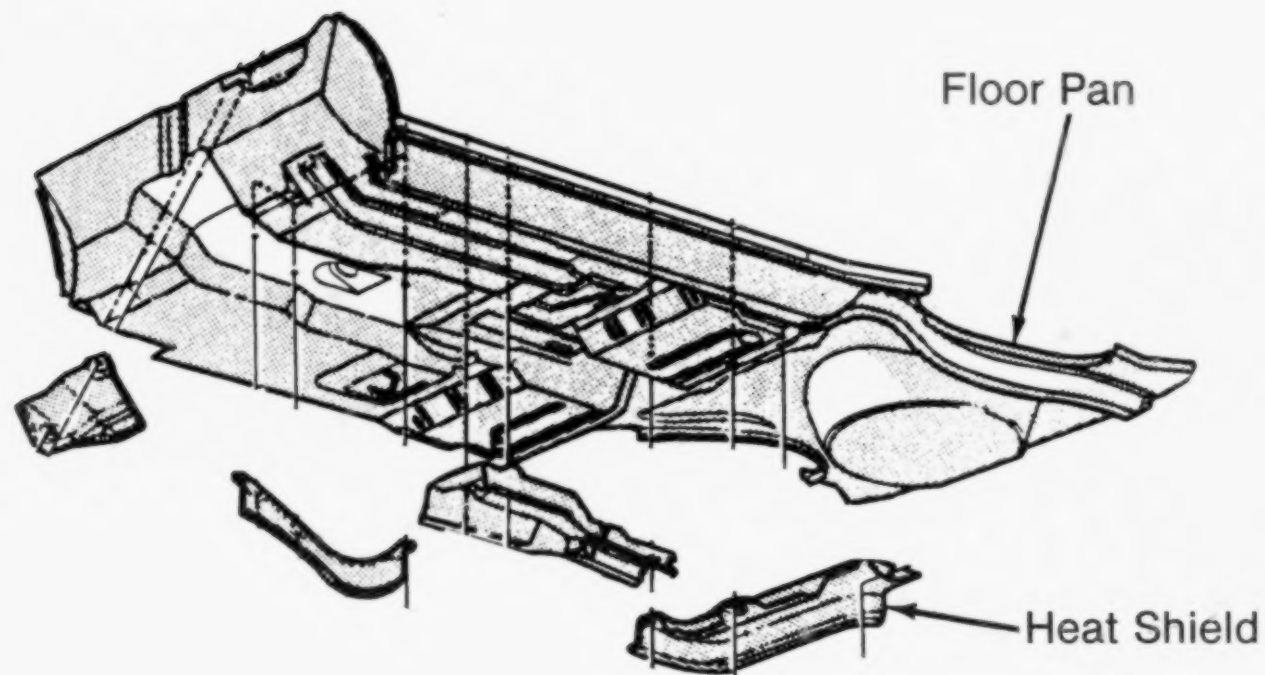
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MacPherson-Strut-Type Front Suspension



Used with permission of Chrysler Corporation.

Floor Pan



Used with permission of Chrysler Corporation.

TM #5

311

312

IAB - 351

BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

INFORMATION SHEET

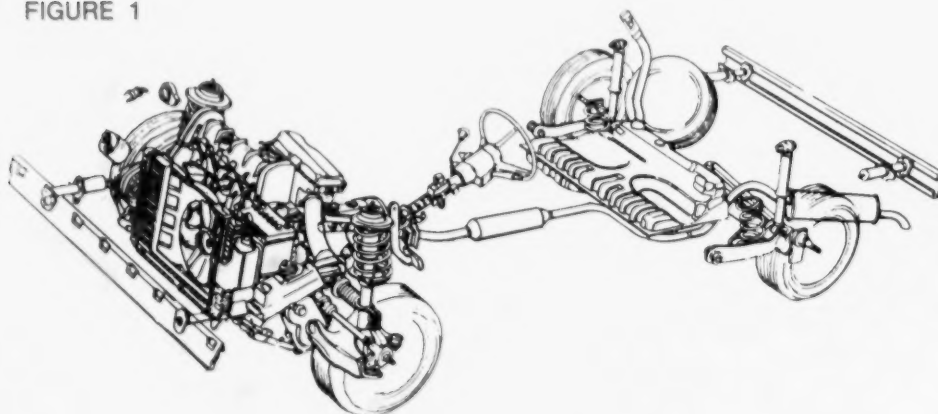
I. Terms and definitions

- A. Mechanical system—Assembly consisting of engine, drive train, and running gear (Figure 1)

(NOTE: The mechanical system may include the frame.)

EXAMPLE:

FIGURE 1

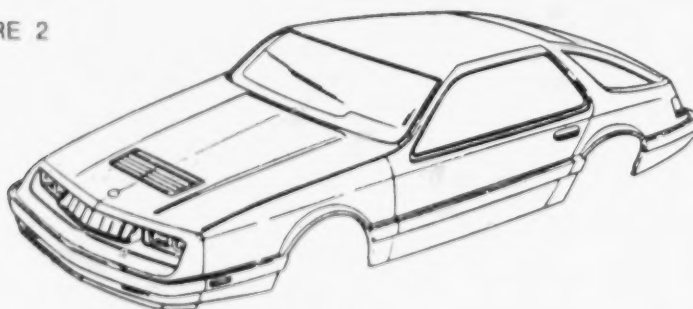


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- B. Body—Contained unit that provides enclosures for passengers, engine, and luggage (Figure 2)

EXAMPLE:

FIGURE 2



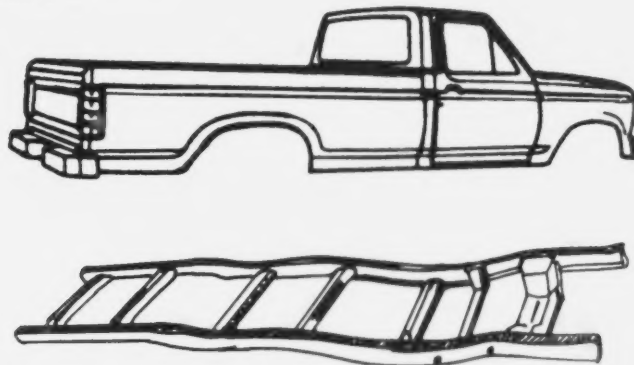
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INFORMATION SHEET

- C. Conventional design—Body construction in which the body and frame are separate units bolted together to form the automobile (Figure 3)

EXAMPLE:

FIGURE 3

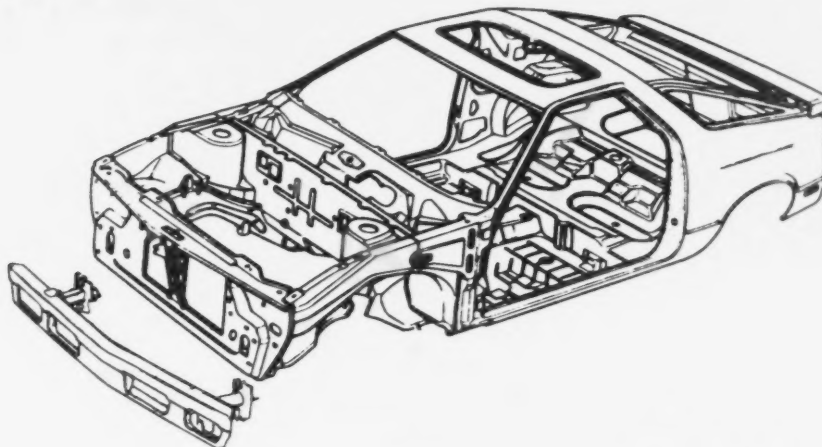


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- D. Unitized design—Body construction in which the body and frame are one unit; a separate frame is not used (Figure 4)

EXAMPLE:

FIGURE 4



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INFORMATION SHEET

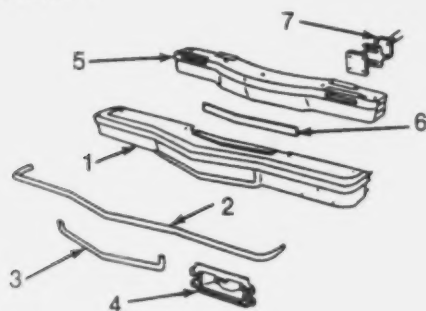
- E. Spot weld—Method of using both arc and resistant spot welds to weld body panels together at the factory

II. Components of the front-end assembly (Figures 5-9)

A. Bumper

EXAMPLE:

FIGURE 5



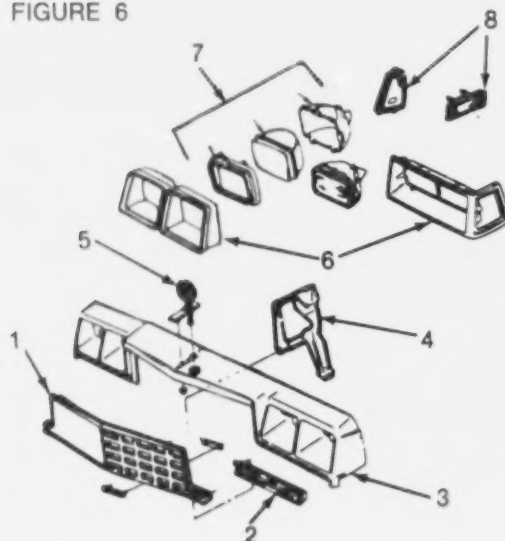
1. Face bar cover
2. Impact pad
3. Lower guard molding
4. License bracket
5. Bar
6. Opening shield
7. Impact absorber

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B. Grille and lamp assembly

EXAMPLE:

FIGURE 6



1. Grille
2. Grille extension
3. Mounting panel
4. Center support
5. Ornament
6. Headlamp door (bezel)
7. Headlamp
8. Side marker lamp

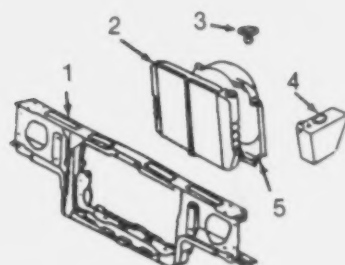
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INFORMATION SHEET

C. Radiator support assembly

EXAMPLE:

FIGURE 7



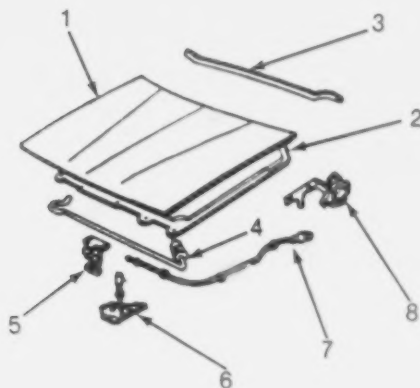
1. Radiator support
2. Radiator
3. Filler cap
4. Coolant reservoir
5. Fan shroud

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D. Hood assembly

EXAMPLE:

FIGURE 8



1. Hood
2. Insulator
3. Cowl seal
4. Support rod
5. Safety latch
6. Lock
7. Release cable
8. Hinge

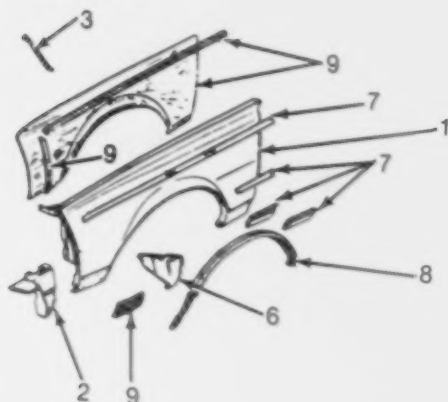
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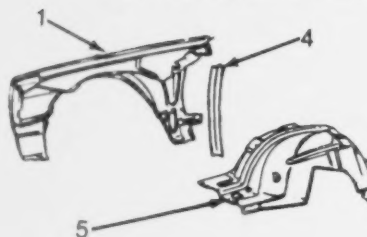
E. Fender assembly

EXAMPLE:

FIGURE 9



1. Fender
2. Fender to bumper filler
3. Brace
4. Seal
5. Wheelhouse
6. Wheelhouse shield
7. Molding
8. Wheel opening molding
9. Overlay, with molding



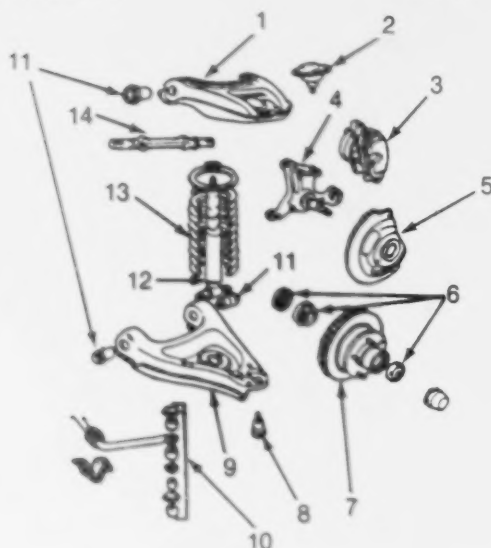
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III. Types of suspensions (Figures 10 and 11)

A. Control arm

FIGURE 10

EXAMPLES:



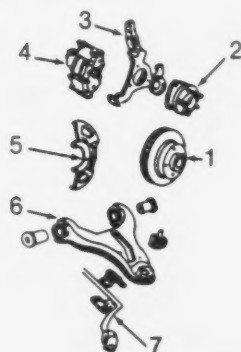
1. Upper control arm
2. Upper ball joint
3. Brake caliper
4. Steering knuckle
5. Splash shield
6. Bearings and seal
7. Hub and disk
8. Lower ball joint
9. Lower control arm
10. Stabilizer assembly
11. Control-arm bushing
12. Shock absorber
13. Spring
14. Control-arm shaft

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INFORMATION SHEET

B. MacPherson strut

FIGURE 11



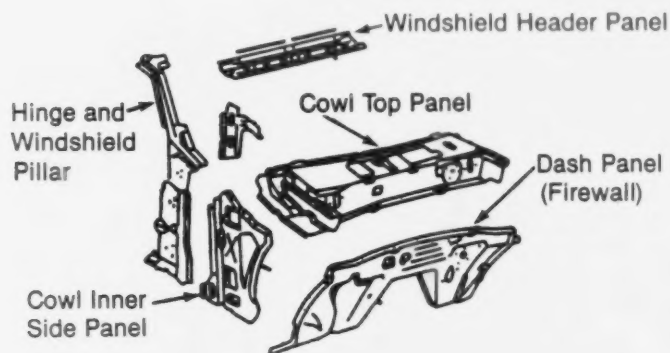
- EXAMPLES:
1. Hub and disk
 2. Bearing and hub
 3. Steering knuckle
 4. Brake caliper
 5. Splash shield
 6. Lower arm/bushing/ball joint assembly
 7. Stabilizer shaft/bushing/bracket/support plate
 8. Shock absorber with strut/spring assembly



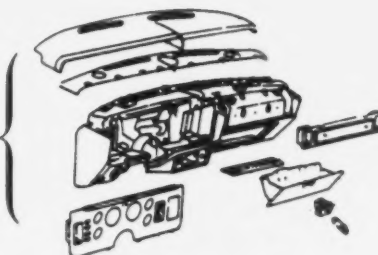
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IV. Front cowl panels (Figure 12)

FIGURE 12



Instrument Panel and Components

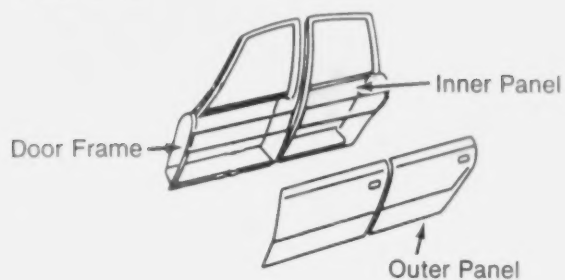


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INFORMATION SHEET

V. Door sections (Figure 13)

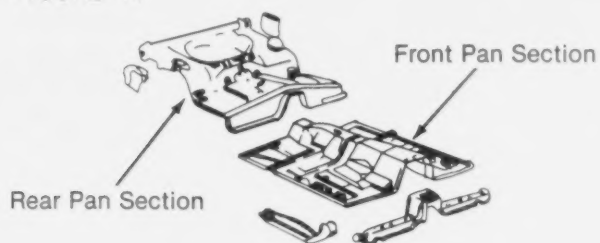
FIGURE 13



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VI. Floor panel sections (Figure 14)

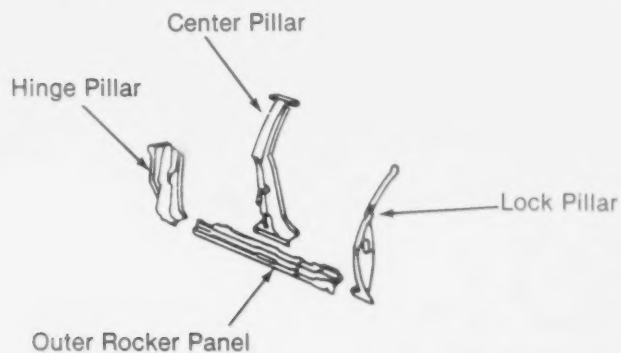
FIGURE 14



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VII. Rocker panel and pillar components (Figure 15)

FIGURE 15

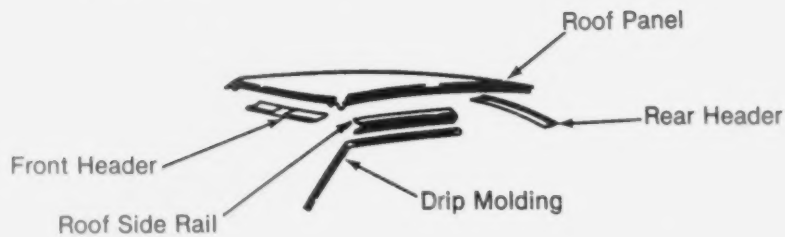


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INFORMATION SHEET

VIII. Roof components (Figure 16)

FIGURE 16



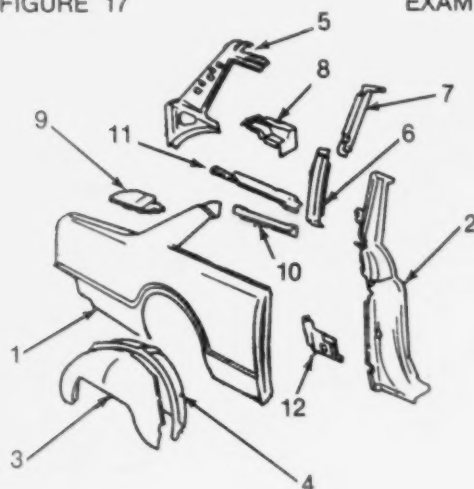
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IX. Major components of the rear body assembly (Figures 17-21)

A. Quarter panel sheet-metal components

FIGURE 17

EXAMPLES:



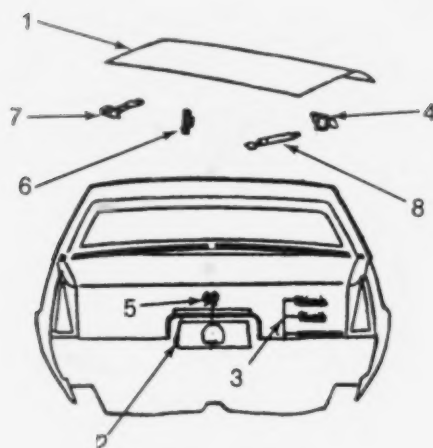
1. Outer panel
2. Lock pillar
3. Outer wheelhouse panel
4. Inner wheelhouse panel
5. Inner upper rear panel
6. Division bar
7. Inner rail extension
8. Package tray support
9. Window opening reinforcement
10. Window retainer
11. Belt rail
12. Lock pillar brace

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INFORMATION SHEET

B. Deck lid

FIGURE 18

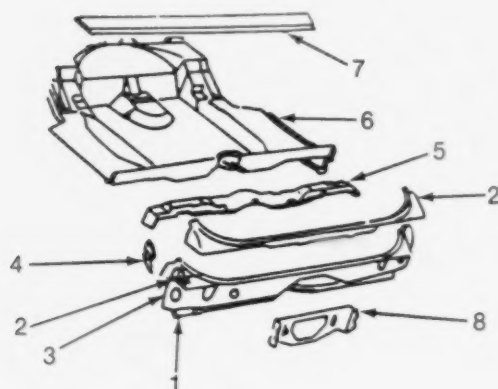


- EXAMPLES:
1. Lid
 2. Molding
 3. Nameplate
 4. Lock
 5. Emblem
 6. Striker and anchor plate
 7. Hinge
 8. Counterbalance support

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C. Rear body

FIGURE 19



- EXAMPLES:
1. Lower panel
 2. Upper panel
 3. Outer finish panel
 4. Panel center reinforcement
 5. Rear pan bar
 6. Rear floor pan
 7. Upper panel (front of deck lid)
 8. License plate pocket

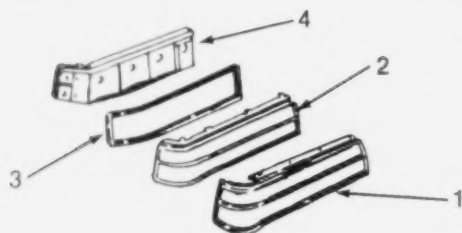
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INFORMATION SHEET

D. Rear lamp

FIGURE 20

- EXAMPLES:
1. Bezel
 2. Lens
 3. Lens gasket
 4. Socket and wire housing

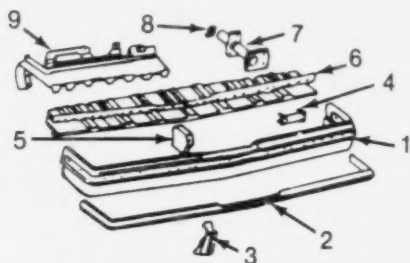


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E. Rear bumper

FIGURE 21

- EXAMPLES:
1. Face bar
 2. Impact pad
 3. Guard
 4. Absorber mounting plate
 5. Inner support reinforcement
 6. Reinforcement
 7. Impact absorber
 8. Absorber bracket
 9. Stone deflector (filler)



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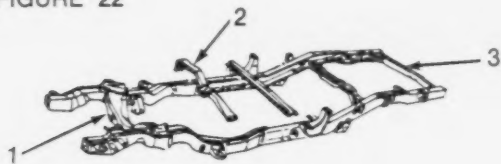
X. Types of frame construction

A. Conventional construction (Figure 22)

EXAMPLE:

FIGURE 22

1. Frame crossmember
2. Transmission support
3. Rear crossmember



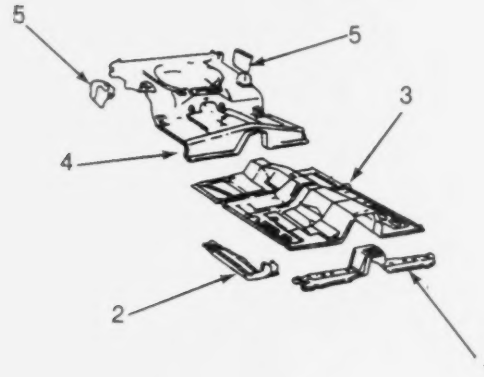
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INFORMATION SHEET

B. Unitized (unibody) construction (Figures 23-25)

EXAMPLE: Floor assembly

FIGURE 23

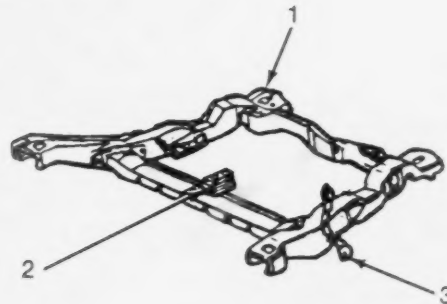


1. Front floor member
2. Rear side of front member
3. Front floor pan
4. Rear floor pan
5. Rear pan extension

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EXAMPLE: Stub frame (optional)

FIGURE 24



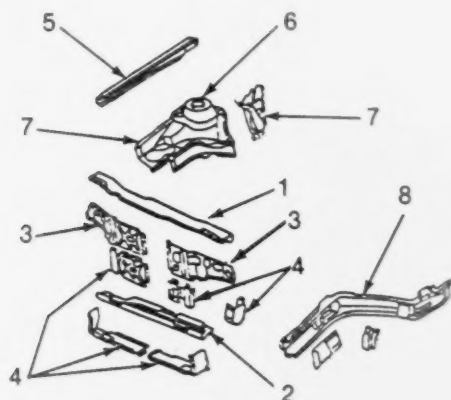
1. Front frame
2. Six-cylinder damper
3. Mounting, cushion, or retaining strap

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INFORMATION SHEET

EXAMPLE: Engine compartment components

FIGURE 25



1. Upper tie bar
2. Lower tie bar
3. Front panels
4. Front panel extensions
5. Upper side rail
6. Side panel with shock tower
7. Side panel
8. Frame side rail/supports

(NOTE: The frame side rails may be part of the stub frame on models using stub frames.)

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**BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI**

**ASSIGNMENT SHEET #1 — USE AUTOMOTIVE REFERENCE TEXTS AND SERVICE
MANUALS TO IDENTIFY BODY AND FRAME COMPONENTS**

NAME _____

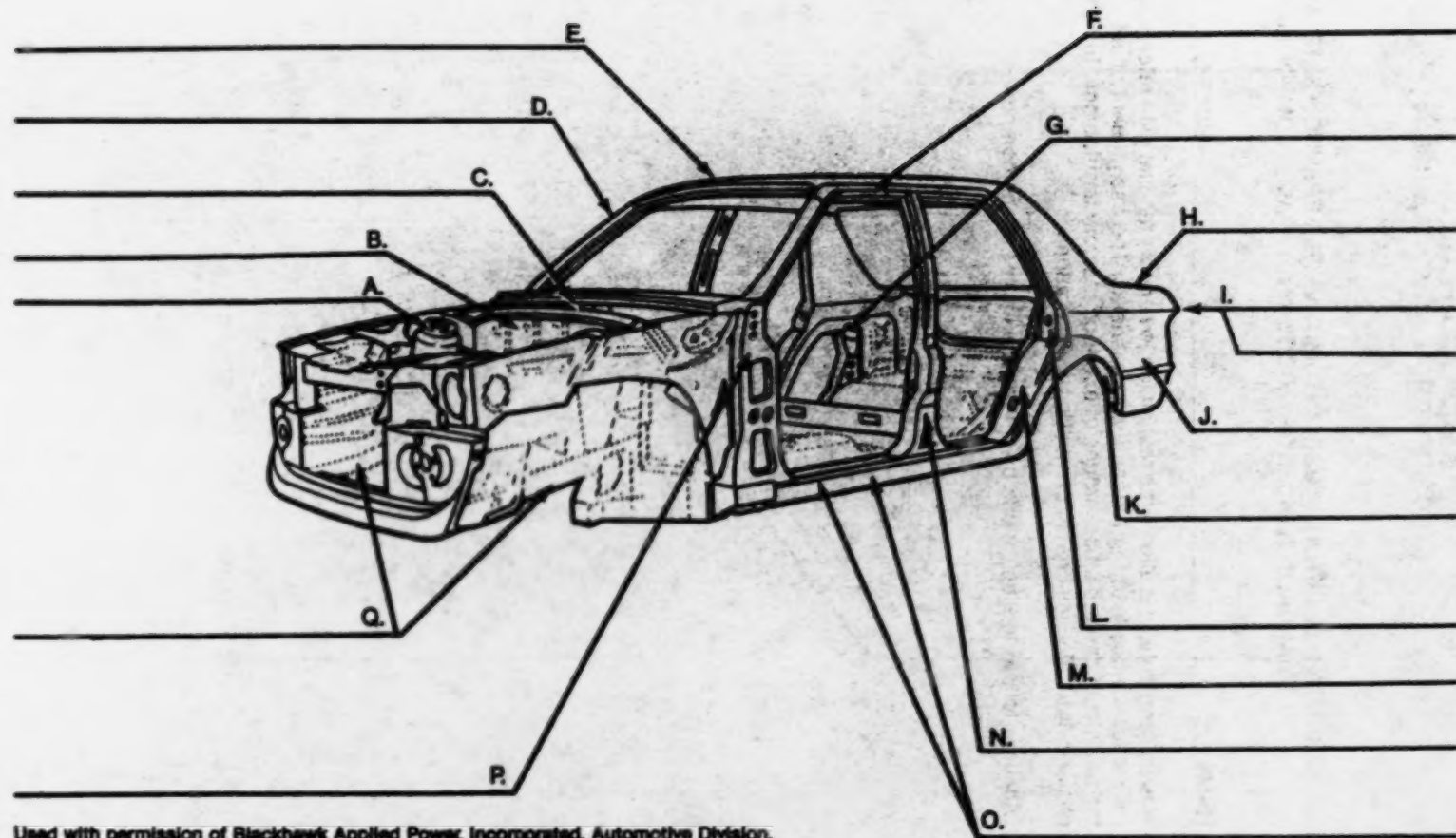
SCORE _____

This assignment sheet allows the technician to become familiar with reference texts and service manuals while learning to identify components. The assignment sheet should also help the technician develop a background of auto-body factory terminology that should prove beneficial in later discussions and actual repair operations.

Label the following illustrations by writing the names of the components in the blanks.

ASSIGNMENT SHEET #1

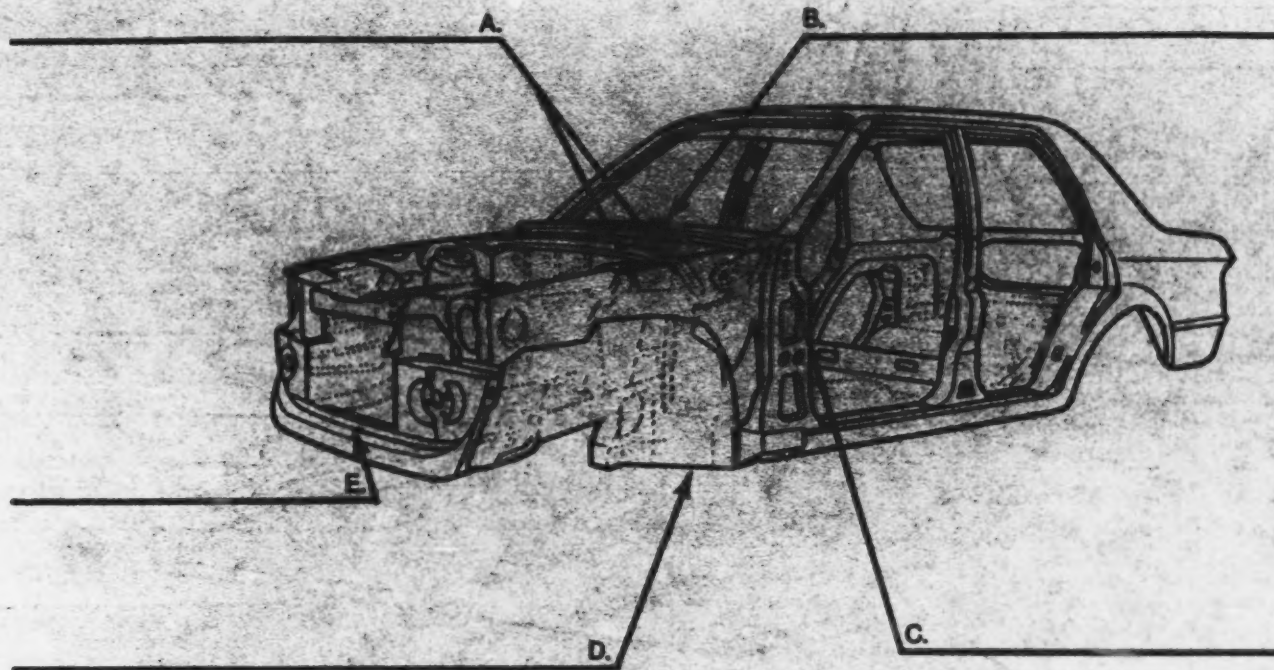
PART I



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ASSIGNMENT SHEET #1

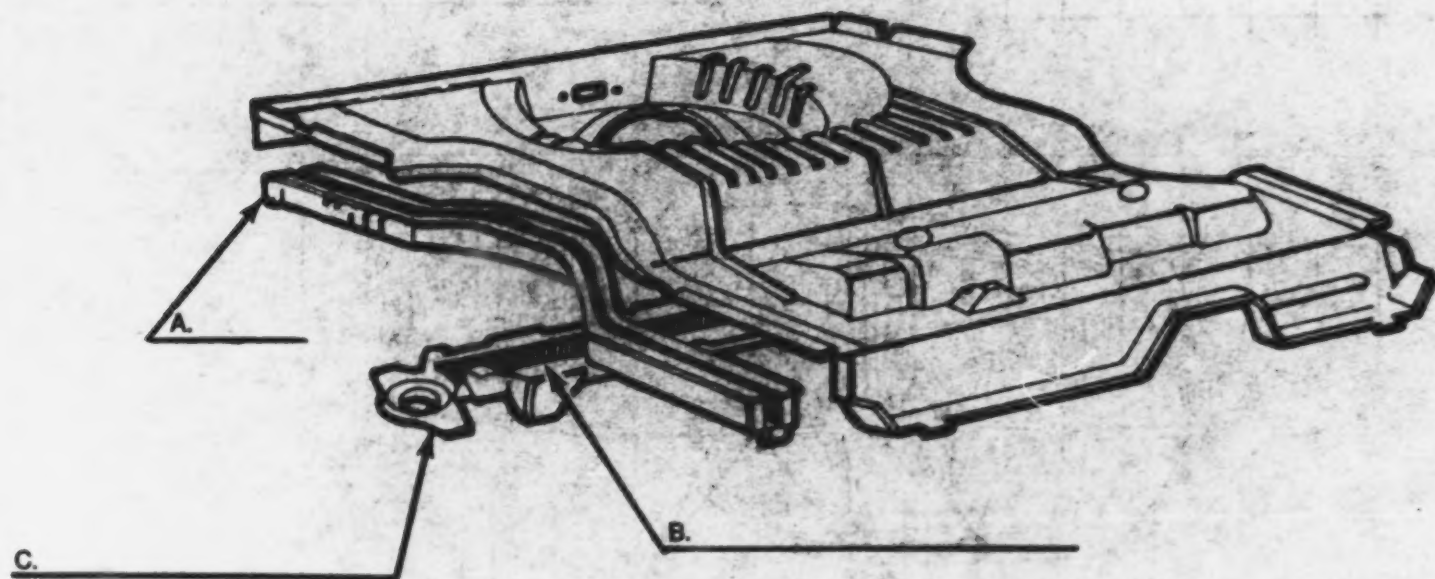
PART II



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PART III

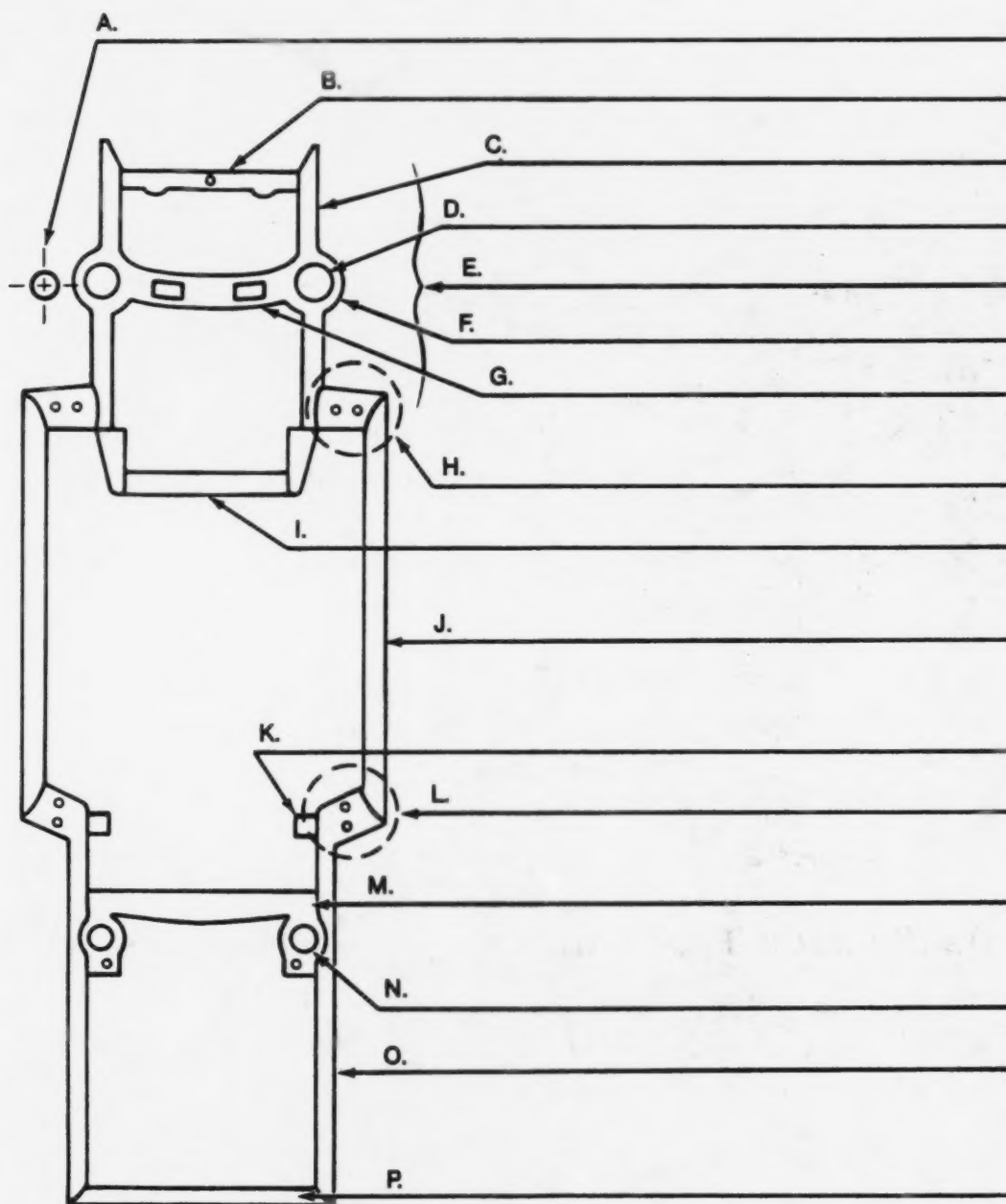
ASSIGNMENT SHEET #1



Used with permission of Blackhawk Applied Power, Incorporated, Automotive Division.

ASSIGNMENT SHEET #1

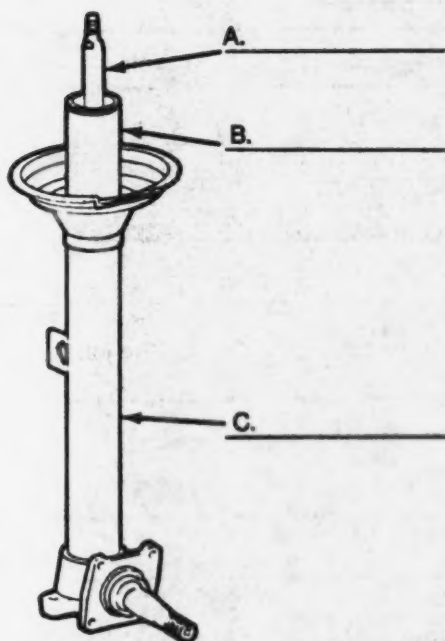
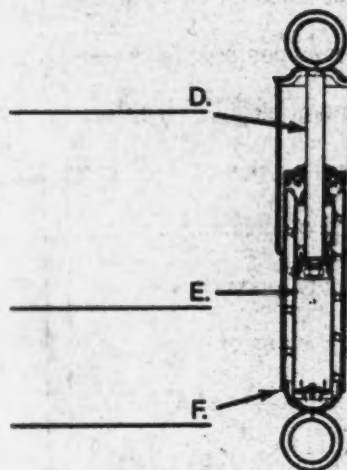
PART IV



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ASSIGNMENT SHEET #1

PART V

**MacPherson-Type Strut****Shock Absorber**

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BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

Part I

- | | |
|------------------------|---------------------------------|
| A. MacPherson tower | J. Rear quarter panel |
| B. Firewall | K. Inner and outer wheelhouse |
| C. Cowl top panel | L. Dog leg |
| D. Windshield pillar | M. Rear lock pillar |
| E. Header bar | N. Center pillar post |
| F. Roof side rail | O. Inner and outer rocker panel |
| G. Rear shock tower | P. Front body hinge pillar |
| H. Deck lid | Q. Inner and outer front rail |
| I. Grease or belt line | |

Part II

- A. Apron reinforcement
- B. Cowl area
- C. Cowl side panel
- D. Apron area
- E. Radiator core support

Part III

- A. Rear rail
- B. Bolt-on rear crossmember
- C. Cradle

Part IV

- | | | |
|---|--------------------------------|--------------------------------|
| A. Lower ball-joint location | G. Main crossmember | M. Rear suspension crossmember |
| B. Front crossmember | H. Torque box | N. Rear spring pod |
| C. Frame horn | I. Transmission support member | O. Rear frame stub |
| D. Upper control arm shim contact point | J. Frame side rail | P. Rear crossmember |
| E. Front frame rail | K. Stabilizer mount | |
| F. Spring pod | L. Torque box | |

Part V

- | | |
|-------------------|---------------|
| A. Strut rod | D. Piston rod |
| B. Strut cylinder | E. Cylinder |
| C. Shell | F. Shell |

BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with automotive body and frame construction. Write the correct numbers in the blanks.

- | | |
|---|------------------------|
| _____a. Body construction in which the body and frame are one unit; a separate frame is not used | 1. Mechanical system |
| _____b. Assembly consisting of engine, drive train, and running gear | 2. Body |
| _____c. Method of using both arc and resistant spot welds to weld body panels together at the factory | 3. Conventional design |
| _____d. Contained unit that provides enclosures for passengers, engine, and luggage | 4. Unitized design |
| _____e. Body construction in which the body and frame are separate units bolted together to form the automobile | 5. Spot weld |

2. List major components of the front-end assembly.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

3. Identify the two types of suspensions illustrated on the following page. Write the correct names in the blanks.

Control arm

McPherson strut

TEST



a. _____

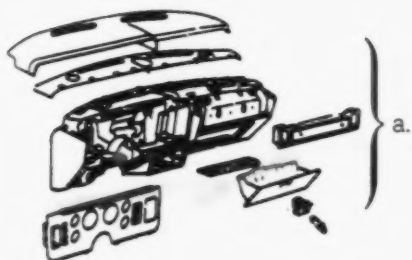


b. _____

4. Identify the front cowl panels illustrated below. Write the correct names in the blanks.

Cowl top panel
Hinge and windshield pillar
Instrument panel and
components

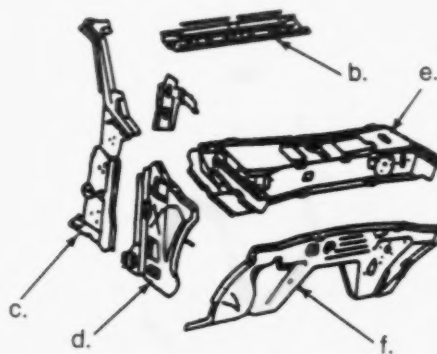
Windshield header panel
Dash panel (firewall)
Cowl inner side panel



a. _____

b. _____

c. _____



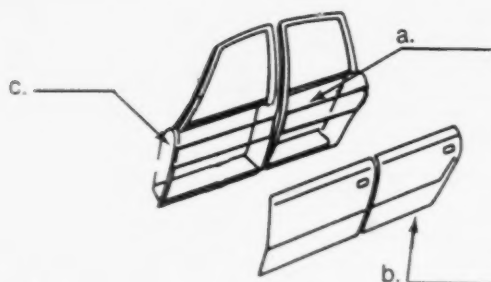
d. _____

e. _____

f. _____

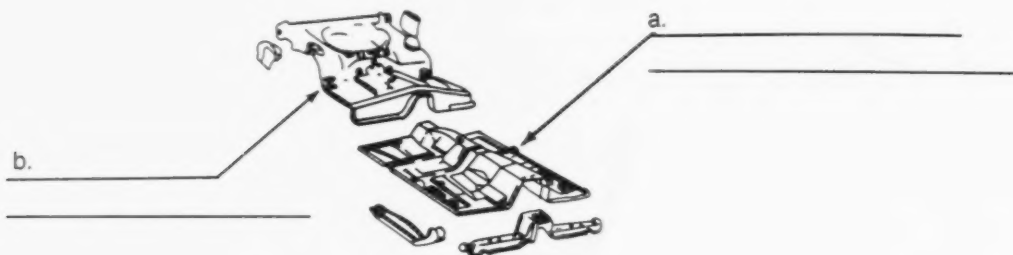
TEST

5. Match the listed door section components to their correct illustrations. Write the correct numbers in the blanks.

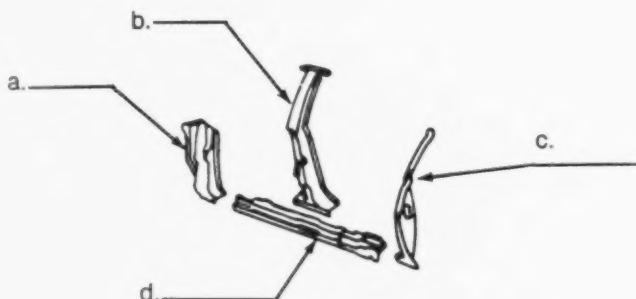


1. Outer panel
2. Door frame
3. Inner panel

6. Label the floor panel sections illustrated below. Write the correct names in the blanks.



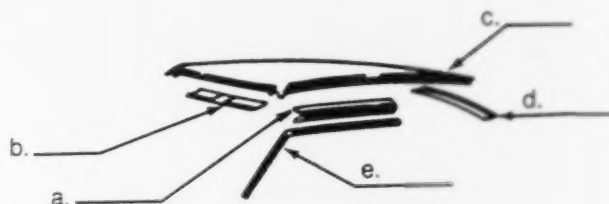
7. Match the listed rocker panel and pillar components to their correct illustrations. Write the correct numbers in the blanks.



1. Outer rocker panel
2. Center pillar
3. Hinge pillar
4. Lock pillar

TEST

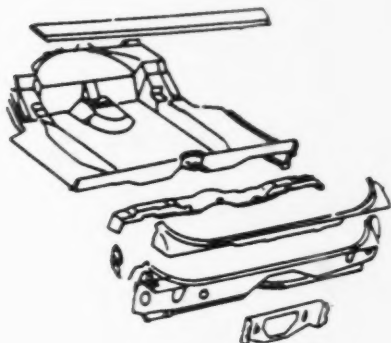
8. Match the listed roof components to their correct illustrations. Write the correct numbers in the blanks.



1. Roof panel
2. Front header
3. Roof side rail
4. Drip molding
5. Rear header

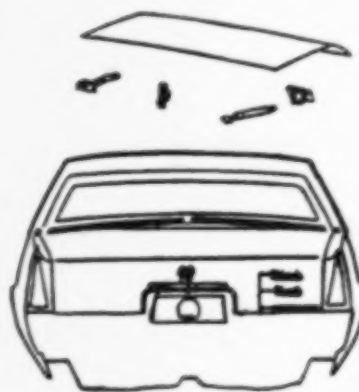
9. Identify the following major components of the rear body assembly. Write the correct names in the blanks.

**Rear body
Quarter panel sheet-
metal components**



a. _____

**Rear bumper
Rear lamp
Deck lid**

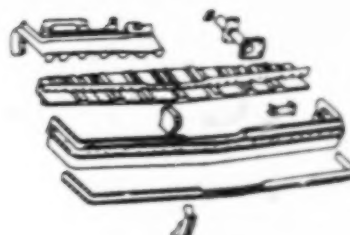


b. _____

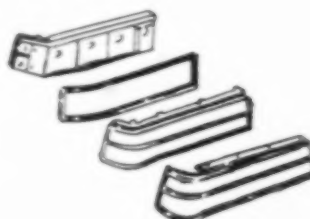
TEST



c. _____



d. _____



e. _____

10. Name types of frame construction.

a. _____

b. _____

(NOTE: Test question 11 lists the assignment sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

11. Use automotive reference texts and service manuals to identify body and frame components.

BODY AND FRAME
CONSTRUCTION NOMENCLATURE
UNIT VI

ANSWERS TO TEST

1. a. 4 d. 2
 b. 1 e. 3
 c. 5
2. a. Bumper d. Hood assembly
 b. Grille and lamp assembly e. Fender assembly
 c. Radiator support assembly
3. a. Control arm
 b. McPherson strut
4. a. Instrument panel and components d. Cowl inner side panel
 b. Windshield header panel e. Cowl top panel
 c. Hinge and windshield pillar f. Dash panel (firewall)
5. a. 3
 b. 1
 c. 2
6. a. Front pan section
 b. Rear pan section
7. a. 3 c. 4
 b. 2 d. 1
8. a. 3 d. 5
 b. 2 e. 4
 c. 1
9. a. Rear body d. Rear bumper
 b. Deck lid e. Rear lamp
 c. Quarter panel sheet-metal components
10. a. Conventional construction
 b. Unitized (unibody) construction
11. Evaluated to the satisfaction of the instructor

GENERAL HAND TOOLS UNIT VII

UNIT OBJECTIVE

After completing this unit, the student should be able to identify general hand tools used in auto-body shops and list rules for care and safe use of hand tools. The student will show this knowledge by completing the job sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with hand tools.
2. State rules for care and safe use of hand tools.
3. Label types of screwdrivers.
4. State guidelines for selecting the correct standard screwdriver for the job.
5. Identify types of wrenches.
6. State guidelines for selecting the correct socket and handle for the job.
7. Identify types of punches.
8. Label types of chisels.
9. Identify types of pliers.
10. Label types of general-purpose files.
11. Identify types of general-purpose hammers.
12. Match types of miscellaneous hand tools to their correct uses.
13. Demonstrate the ability to hand tap a hole in a piece of steel.

GENERAL HAND TOOLS
UNIT VII

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Transparency masters
 - 1. TM #1 — Right and Wrong Uses of a Wrench
 - 2. TM #2 — Right and Wrong Uses of a Wrench (Continued)
 - 3. TM #3 — Right and Wrong Uses of a Wrench (Continued)
 - 4. TM #4 — Right and Wrong Uses of a Cold Chisel
 - 5. TM #5 — Right and Wrong Uses of Pliers
 - 6. TM #6 — Right and Wrong Uses of a General-Purpose File
 - 7. TM #7 — Right and Wrong Uses of a General-Purpose File (Continued)
 - 8. TM #8 — Right and Wrong Uses of a General-Purpose File (Continued)
 - 9. TM #9 — Right and Wrong Uses of a General-Purpose Hammer
 - 10. TM #10 — Right and Wrong uses of a General-Purpose Hammer (Continued)
- D. Information sheet
- E. Assignment Sheet # 1 — Complete Safety Test for Hand Tools
- F. Answers to assignment sheet
- G. Job Sheet #1 — Hand Tap a Hole in a Piece of Steel
- H. Test
- I. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.

(NOTE: Review Unit VIII, "Body and Refinishing Equipment." Other types of hand tools and hand-tool safety are also covered in that unit, and you may want to incorporate parts of that unit in your discussion of general shop tools.)

SUGGESTED ACTIVITIES

B. Obtain materials to supplement unit.

1. *Safety in the Shop: Hand Tools*

(NOTE: This black and white film is 13.5 minutes long, and is available from Coronet Films, 65 East South Water Street, Chicago, Illinois 60601.)

2. *Tool Identification Slides*

(NOTE: This slide set is available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

3. Tool catalogs

4. Newspaper clippings or case studies that relate to safe hand-tool use

5. Samples of the screwdrivers, screws, wrenches, punches, chisels, pliers, files, hammers, and miscellaneous hand tools illustrated in this unit

6. Damaged screws and screwdrivers and flat-ground and hollow-ground screwdrivers

7. Six-point, twelve-point, and speciality sockets

8. Nuts and bolts of varying configurations, sizes, and lengths

9. Chisel with a mushroomed head

10. File card

11. Equipment and materials needed for job sheet

12. Transparencies and competency profiles

(NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Introduce unit.

SUGGESTIONS:

- Explain that students will be expected to provide their own set of hand tools before starting to work.
- Ask students to review tool catalogs. Discuss hand tools, pointing out the importance of buying good grades of tools. Tell students that quality, not price, should be their main concern when purchasing tools.
- Show *Tool Identification Slides*.

SUGGESTED ACTIVITIES

- Explain to students that this unit does not contain all the hand tools they will find in every body shop, but that it does contain most of the general hand tools found in all shops. Other hand tools will be discussed in Unit VIII, "Body and Refinishing Equipment."

- D. Provide students with unit.
- E. Discuss unit and specific objectives, emphasizing the care and safe use of hand tools.
- F. Discuss information, assignment, and job sheets.
 1. Use Information Sheet, Section I to introduce terms and definitions associated with hand tools.

SUGGESTION:

- Discuss or demonstrate terms that may be unfamiliar to students.

2. Use Information Sheet, Section II to discuss rules for care and safe use of hand tools.

SUGGESTIONS:

- Show film *Safety in the Shop: Hand Tools*.
 - Have students recall accidents caused by someone using hand tools improperly.
 - Discuss newspaper clippings or case studies that relate to safe hand-tool use.
 - Discuss specific hand-tool procedures that require the technician to wear eye protection.
 - Demonstrate how to clean and store hand tools properly.
 - Explain your policy for replacement of damaged tools.
 - Outline your tool-management policy for the shop.
 - Have students complete Assignment Sheet #1.
3. Use Information Sheet, Section III to discuss types of screwdrivers.

SUGGESTIONS:

- Display a sample of each type of screwdriver illustrated in this section of the information sheet; also display various screws. Discuss the correct use of screwdrivers, and allow students to examine screwdrivers and screws.
- Demonstrate the correct method for driving screws and the technique of using pilot holes as an aid in driving screws.

SUGGESTED ACTIVITIES

- Have students practice driving various types of screws into pieces of hardwood or strips of metal.
4. Use Information Sheet, Section IV to discuss guidelines for selecting the correct standard screwdriver for the job.

SUGGESTIONS:

- Point out that the screwdriver blade must be the same size as the screw slot it will be used on. Stress that a mismatch will damage the screwdriver tip, the head of the screw, or both.
 - Show students a hollow-ground and a flat-ground screwdriver blade. Demonstrate how torque is exerted improperly when a flat-ground blade is used.
5. Use Information Sheet, Section V to discuss types of wrenches.

SUGGESTIONS:

- Display a sample of each wrench illustrated in this section of the information sheet. Allow students to examine wrenches.
 - Use Transparencies #1 through #3 to illustrate a discussion of right and wrong uses of wrenches.
 - Explain that ratchet wrenches are not designed to withstand extreme force and should not be used for loosening frozen nuts or bolts.
6. Use Information Sheet, Section VI to discuss guidelines for selecting the correct socket and handle for the job.

SUGGESTIONS:

- Display samples of six-point, twelve-point, and speciality sockets. Allow students to examine these sockets.
 - Display several nuts and bolts of varying configurations, sizes, and lengths. Have students practice selecting the correct socket and socket handle for each nut and bolt.
7. Use Information Sheet, Section VII to discuss types of punches.

SUGGESTION:

- Display a sample of each punch illustrated in this section of the information sheet, and discuss the correct use of punches. Allow students to examine the punches.
8. Use Information Sheet, Section VIII to discuss types of chisels.

SUGGESTIONS:

- Display a sample of each chisel illustrated in this section of the information sheet. Discuss proper use of chisels, and allow students to examine chisels. Discuss the differences between a chisel and a punch.

SUGGESTED ACTIVITIES

- Show students a chisel with a mushroomed head or use Transparency #4 to illustrate such a chisel. Caution students against using a chisel with a mushroomed head. Discuss what causes chisels to mushroom and the techniques students can use to slow the mushrooming process.
 - Demonstrate using a hammer and chisel for cutting a nut from a bolt.
9. Use Information Sheet, Section IX to discuss types of pliers.

SUGGESTIONS:

- Display a sample of each of the pliers illustrated in this section of the information sheet, and allow students to examine pliers.
- Remind students to use the correct tool for the job—pliers should not be used as wrenches to adjust nuts and bolts. Use Transparency #5 to point out that nuts and bolts are frequently ruined when someone uses pliers instead of a wrench.
- Have students list the correct uses for pliers.

EXAMPLES: Removing jammed staple in staple gun; removing cap on used glue bottle; fishing a wire out of a hole; removing damaged screws

10. Use Information Sheet, Section X to discuss types of general-purpose files.

SUGGESTIONS:

- Display a sample of each type of file illustrated in this section of the information sheet. Allow students to examine the files.
- Discuss the proper use of files, and use Transparency #6 to caution students against using a file without a handle.
- Demonstrate or use Transparency #7 to show the correct method of tightening a file handle.
- Point out to students that files have a series of cutters set at an angle so that they cut in one direction only and that trying to file in the wrong direction ruins the file.
- Demonstrate or use Transparency #8 to show the correct method of cleaning a file with a file card.

11. Use Information Sheet, Section XI to discuss types of general-purpose hammers.

SUGGESTIONS:

- Display a sample of each type of hammer illustrated in this section of the information sheet. Discuss proper use of hammers, and allow students to examine hammers.

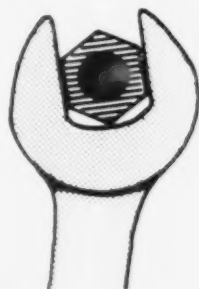
SUGGESTED ACTIVITIES

- Demonstrate or use Transparency #9 to show the correct method of striking a surface with the face of the hammer.
 - Use Transparency #10 to caution students against hitting a surface with a hammer handle.
12. Use Information Sheet, Section XII to discuss miscellaneous hand tools and their correct uses.

SUGGESTIONS:

- Display a sample of each type of tool illustrated in this section of the information sheet. Discuss the correct use of each tool, and allow students to examine tools.
 - Discuss and demonstrate the procedures outlined in Job Sheet #1.
 - Have students complete Job Sheet #1.
- G. Set up a contest to determine which students can use each tool safely, quickly, and accurately.
- H. Give test.
- I. Critique test and discuss in class.
- J. Reteach and retest as necessary.
- K. Complete appropriate section of competency profiles.
- III. Unit references
- A. Crouse, William H. and Donald L. Anglin. *Automotive Body Repair and Refinishing*. New York: McGraw-Hill Book Company, Inc., 1980.
 - B. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Company of Canada, Ltd., 1969.
 - C. McPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Book Company, Inc. 1971.
 - D. Sargent, Robert L. *Automobile Sheet Metal Repair*, 2nd ed. Philadelphia, Pennsylvania: Chilton Book Company, 1969.
 - E. Spicer, Edward K. *Automotive Collision Work*, 4th ed. Chicago, Illinois: American Technical Society, 1972.
 - F. *Stanley Tool Catalog 1982*. New Britain, Connecticut: Stanley Tool Company, 1982.

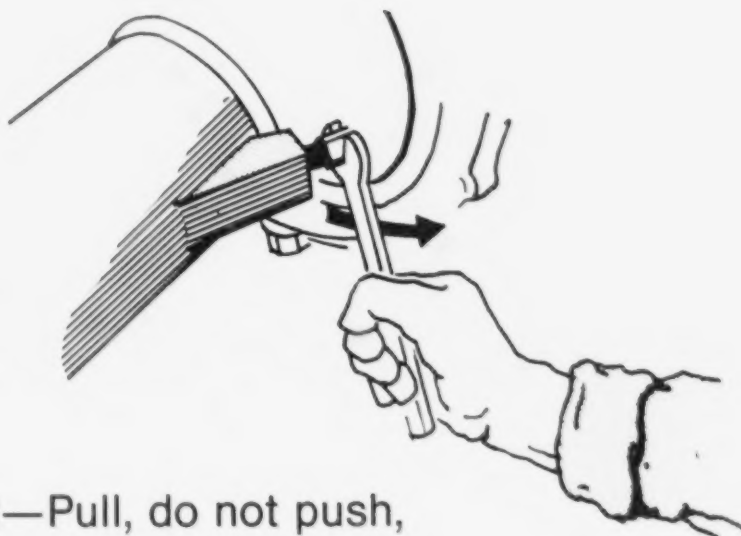
Right and Wrong Uses of a Wrench



Right—Use a wrench that fits the nut or bolt you are working on.

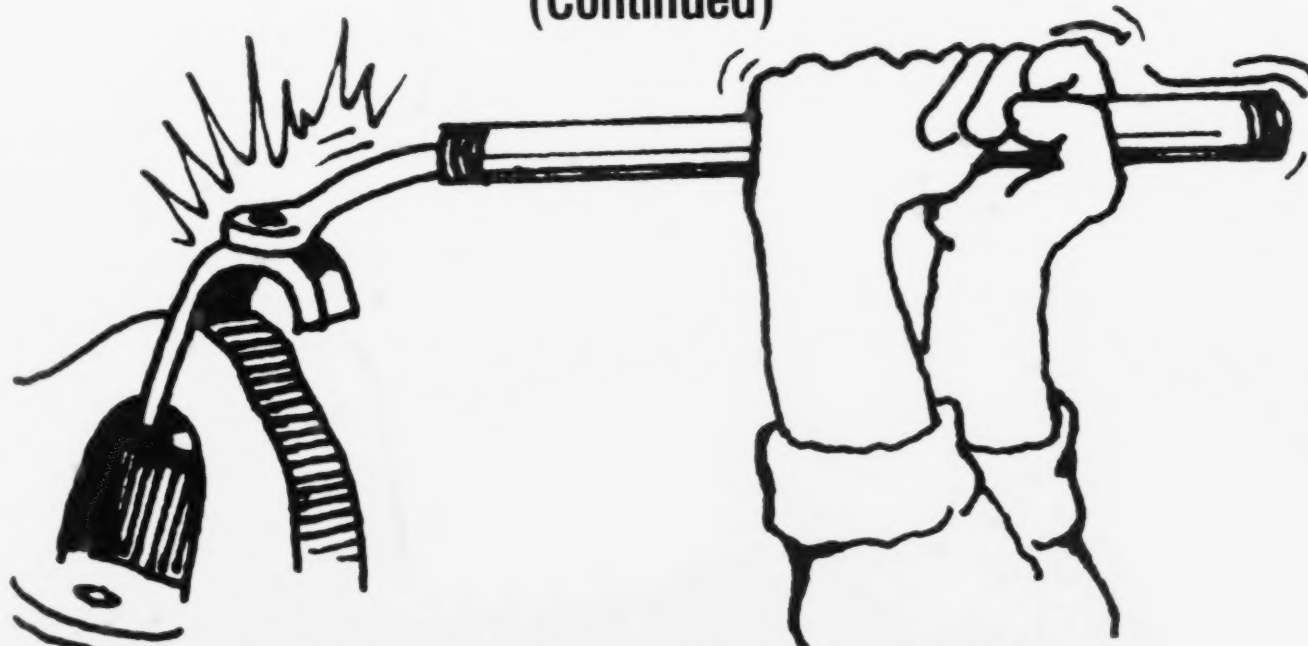


Wrong—*Never* use a wrench that is too large for the nut or bolt you are working on.



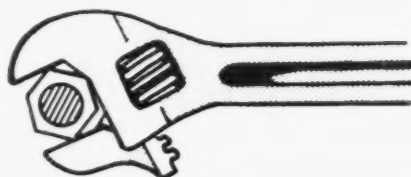
Right—Pull, do not push, when using a wrench.

Right and Wrong Uses of a Wrench (Continued)

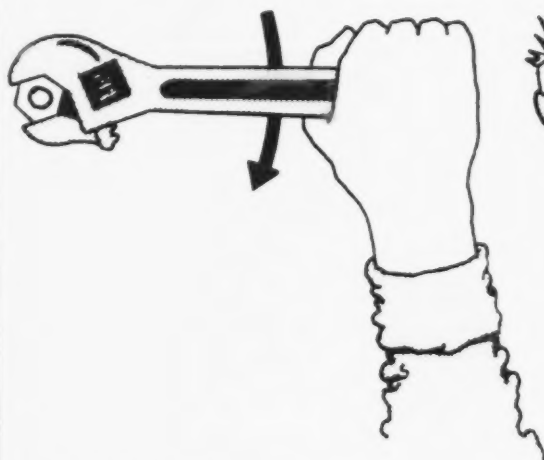


Wrong—*Never* use a bar or a pipe to extend the wrench handle. The extra force may bend or break the wrench.

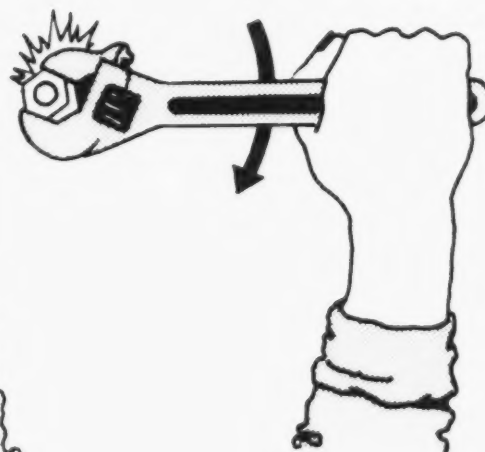
Right and Wrong Uses of a Wrench (Continued)



Wrong—*Never* pull on an adjustable wrench until it has been tightened on the nut.



Right—When using an adjustable wrench, exert force against the large jaw.

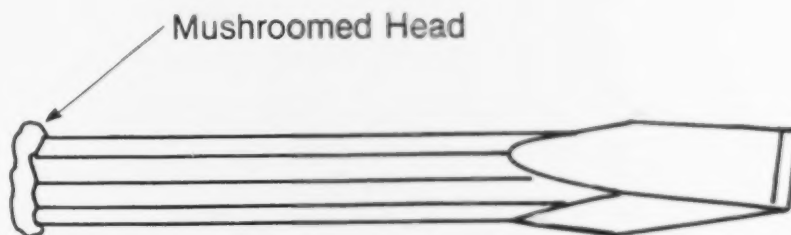


Wrong—*Never* exert force against the small jaw of an adjustable wrench.

Right and Wrong Uses of a Cold Chisel

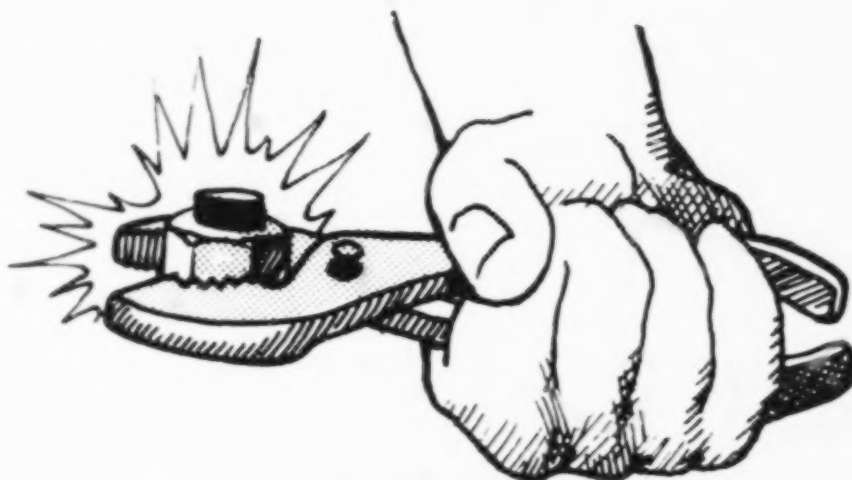


Right—Use a cold chisel with a properly ground head.

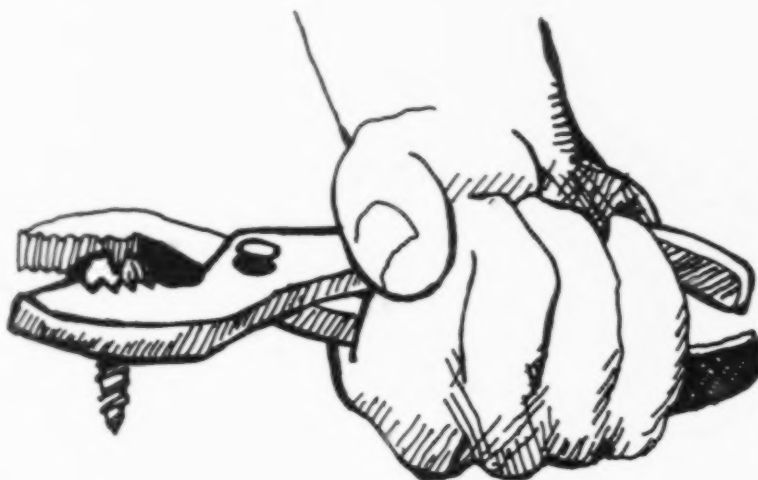


Wrong—*Never* use a cold chisel with a mushroomed head.

Right and Wrong Uses of Pliers

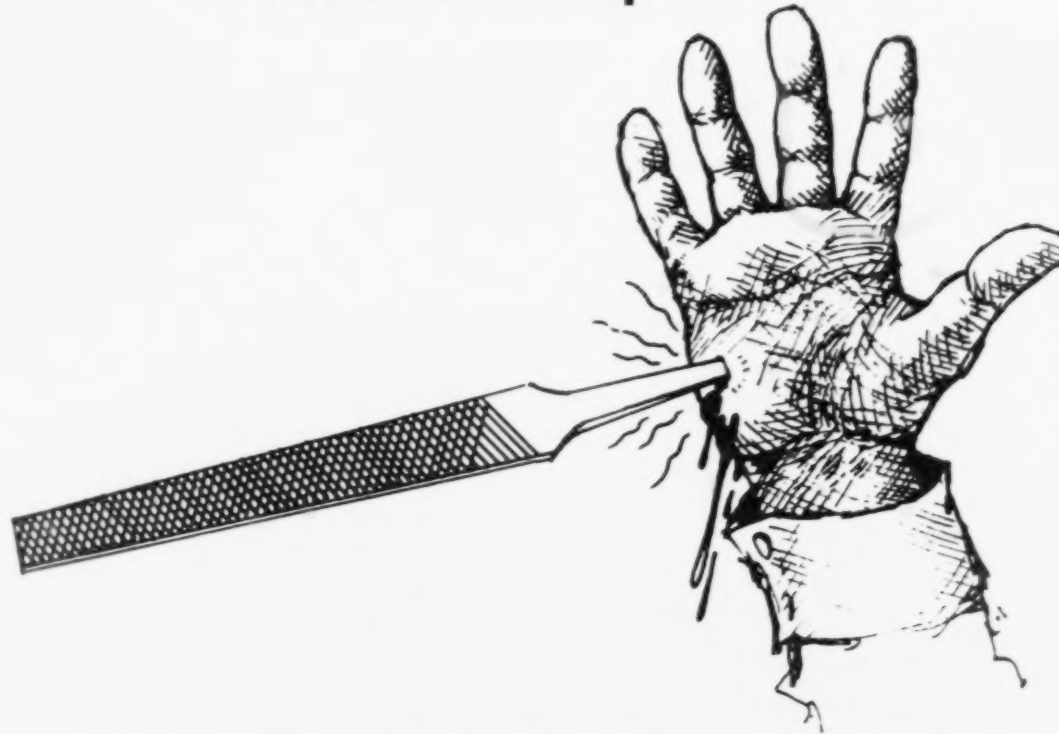


Wrong—Never use pliers to loosen nuts and bolts.



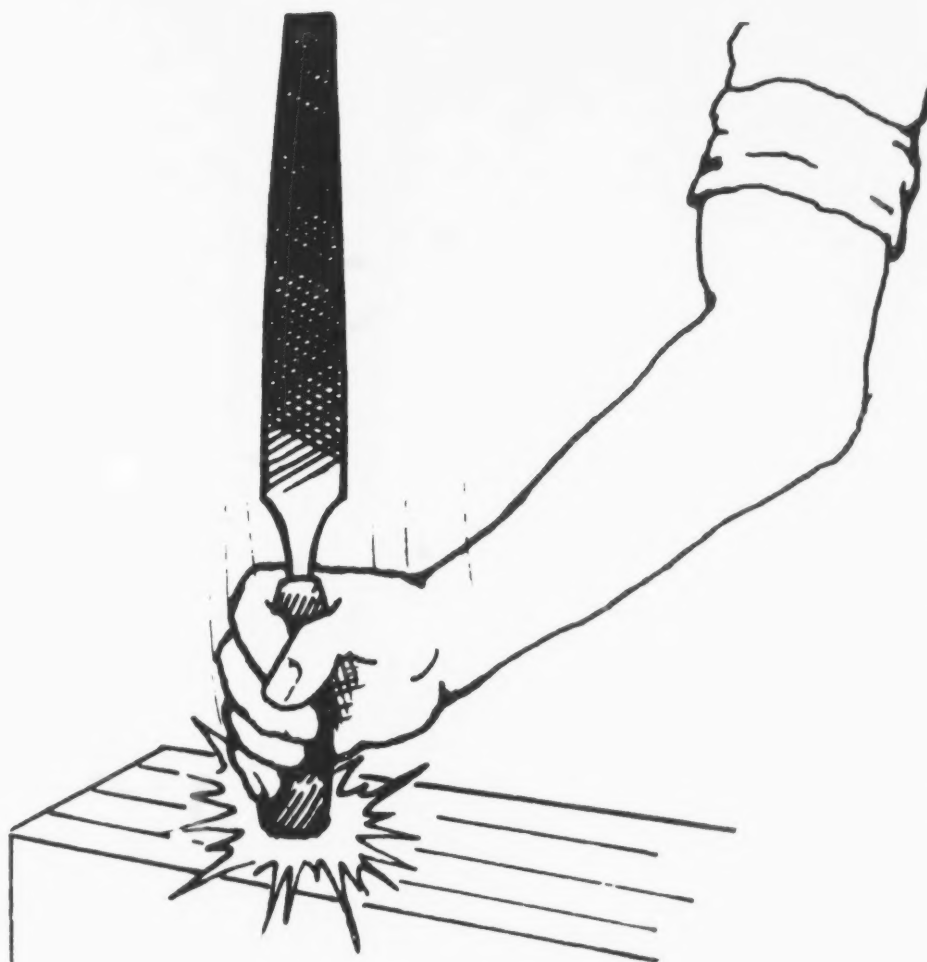
Right—Use pliers for removing damaged screws.

Right and Wrong Uses of a General-Purpose File



Wrong—*Never* use a file without a handle.

Right and Wrong Uses of a General-Purpose File (Continued)



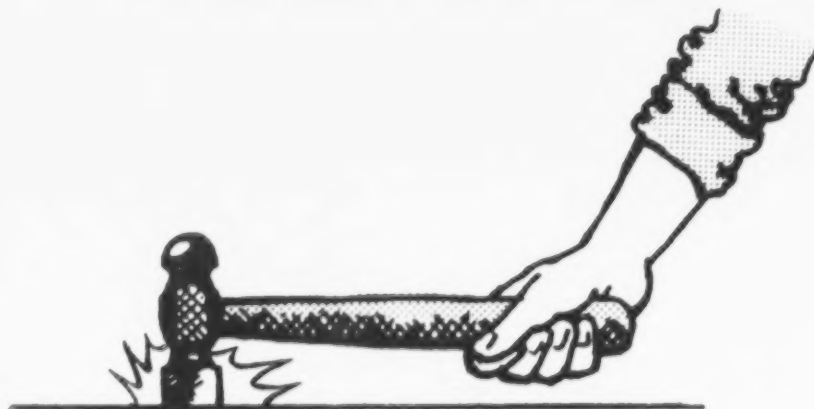
Right—Tighten a file handle
by tapping it on a solid object.

Right and Wrong Uses of a General-Purpose File (Continued)

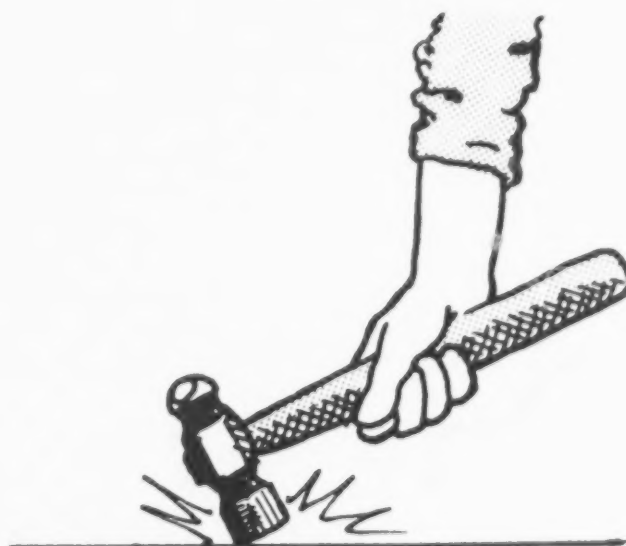


Right—Clean a file by using a file card.

Right and Wrong Uses of a General-Purpose Hammer

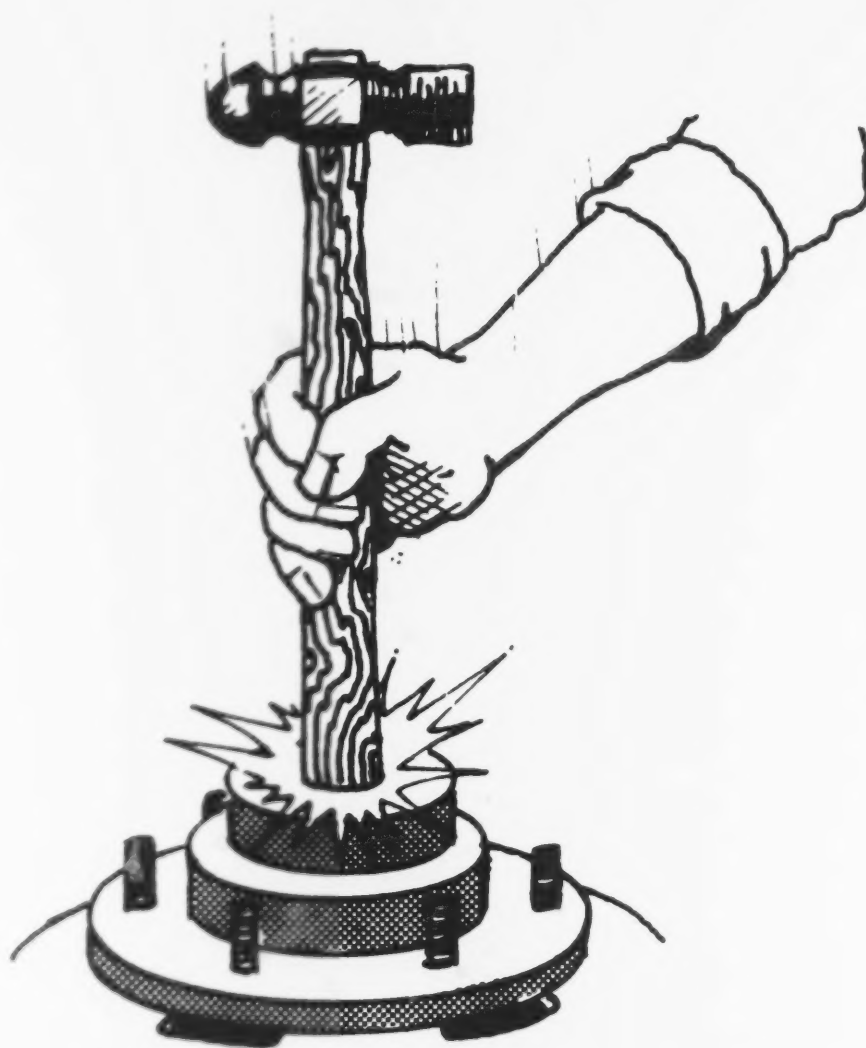


Right—Hit a surface with the full face of the hammer.



Wrong—Never hit a surface with the edge of the hammer's face.

Right and Wrong Uses of a General-Purpose Hammer (Continued)



Wrong—*Never* hit a surface with
the hammer's handle.

GENERAL HAND TOOLS
UNIT VII

INFORMATION SHEET

I. Terms and definitions

- A. Configuration — Arrangement of parts
- B. Drive size — Width of square peg or hole on socket tools
- C. Wheel lugs — Nuts or bolts holding vehicle wheels in place
- D. Torque — Turning or twisting force

II. Rules for care and safe use of hand tools

- A. Wear appropriate eye protection (Figures 1-4)

EXAMPLES:

FIGURE 1: Goggles

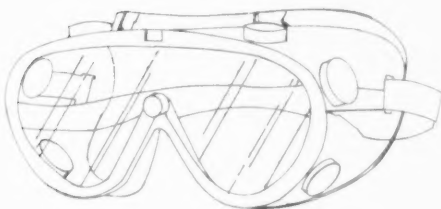


FIGURE 2: Safety glasses

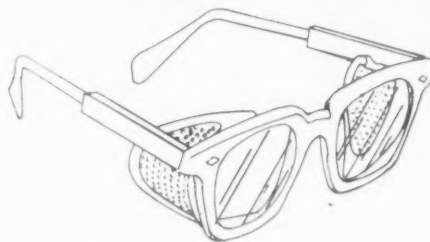


FIGURE 3: Welding goggles

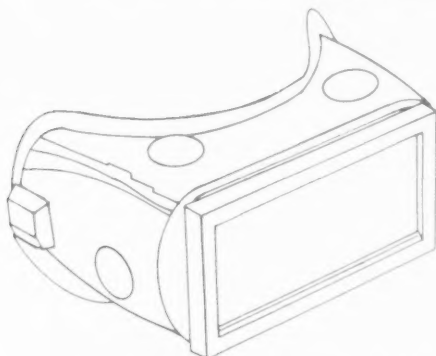
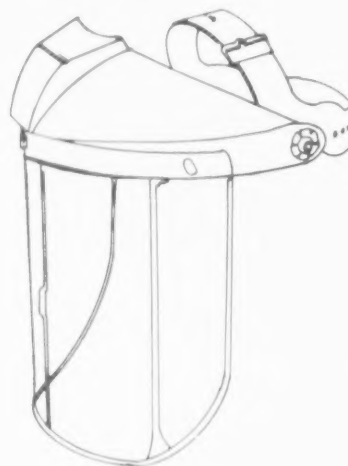


FIGURE 4: Safety shield



- B. Use the correct tool for the job
- C. Keep cutting tools sharp

INFORMATION SHEET

- D. Keep tools clean
- E. Inspect tools frequently to make sure that they are in good condition
- F. Dispose of broken or damaged tools that cannot be repaired
- G. Store tools properly when not in use

EXAMPLES: Do not carry tools in your pockets; do not place tools on workbench where they can roll off; protect cutting edges; lightly oil tools before storing; store tools in dry place.

- H. Stay alert when using tools

EXAMPLES: Keep fingers away from cutting edges; work away from your body when using cutting tools.

III. Types of screwdrivers (Figures 5-9)

(NOTE: Screwdrivers are used to loosen and tighten screws. There are many types and sizes of screwdrivers because each type of screwdriver is made for a certain type and size of screw.)

- A. Standard screwdriver (straight-blade screwdriver)

FIGURE 5



- B. Phillips screwdriver

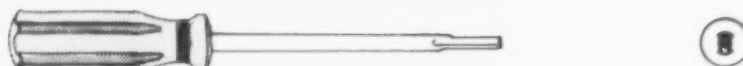
FIGURE 6



INFORMATION SHEET

C. Clutch screwdriver

FIGURE 7



D. Torx screwdriver

FIGURE 8



E. Reed and Prince screwdriver

FIGURE 9



IV. Guidelines for selecting the correct standard screwdriver for the job

- A. Select screwdriver with blade the same size as screw slot it will be used on

EXAMPLE: A standard screwdriver should be used on a standard screw slot, and the screwdriver blade should fit the width of the slot correctly. A mismatch will damage the screwdriver tip, the head of the screw, or both. See Figures 10 and 11.

FIGURE 10: Correct fit



FIGURE 11: Incorrect fit



INFORMATION SHEET

- B. Select screwdriver that has a hollow-ground blade (Figure 12)

(NOTE: A flat-ground blade exerts torque improperly and damages the screwdriver and the screw slot. See Figure 13.)

EXAMPLES:

FIGURE 12: Hollow-ground screwdriver blade



FIGURE 13: Flat-ground screwdriver



- V. Types of wrenches (Figures 14-19)

(NOTE: Wrenches are used to grip and then turn the head on a nut or bolt. There are many sizes of wrenches because there are many sizes of nuts and bolts.)

- A. Open-end wrench

FIGURE 14



- B. Box-end wrench

FIGURE 15



INFORMATION SHEET

C. Combination-end wrench

FIGURE 16



D. Adjustable wrench

FIGURE 17



E. Ratchet wrench

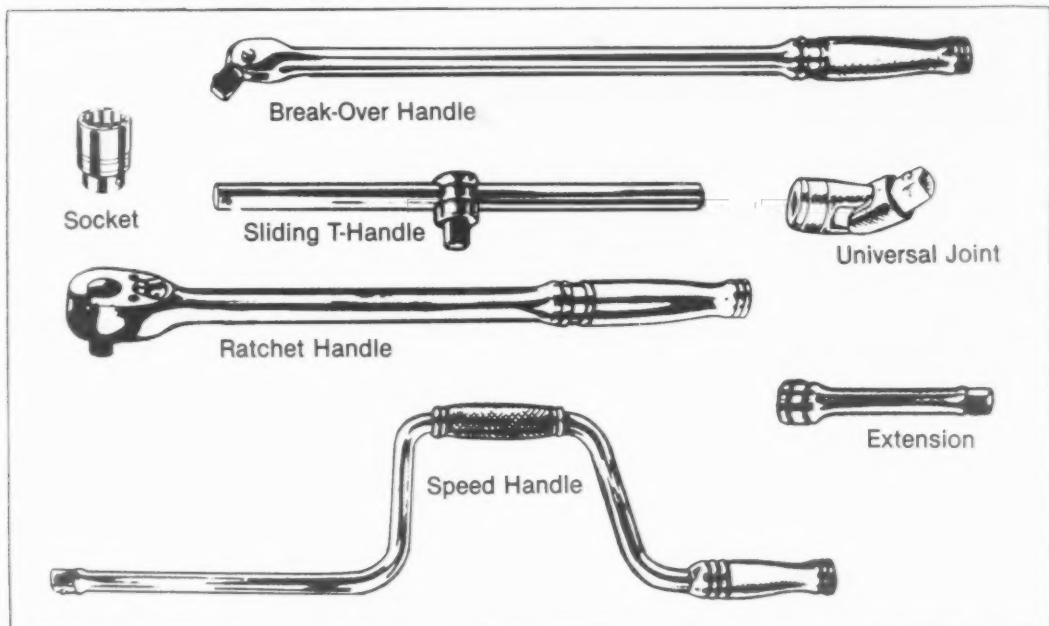
FIGURE 18



F. Socket-wrench set

(NOTE: A socket-wrench set is a collection of handles, extensions, and sockets that may be interchanged or connected in different ways.)

FIGURE 19: Components of a socket-wrench set



INFORMATION SHEET

VI. Guidelines for selecting the correct socket and handle for the job

A. Select socket that is same size as nut or bolt head it will be used on

(NOTE: Socket sizes are measured in metric units [millimeters] or in United States Customary System units [inches]. See Table 1.)

EXAMPLE:

TABLE 1: Comparison of socket sizes (metric and USCS)

Socket	Metric Size	Decimal Equivalent in Inches		USCS Size	Socket	Metric Size	Decimal Equivalent in Inches		USCS Size
	3 mm	0.118	0.125	1/8 Inch		16 mm	0.630	0.625	5/8 Inch
	4 mm	0.157	0.187	3/16 Inch		18 mm	0.709	0.687	11/16 Inch
	6 mm	0.236	0.250	1/4 Inch		19 mm	0.748	0.750	3/4 Inch
	9 mm	0.354	0.312	5/16 Inch		20 mm	0.787	0.812	13/16 Inch
	10 mm	0.394	0.375	3/8 Inch		22 mm	0.866	0.875	7/8 Inch
	12 mm	0.472	0.437	7/16 Inch		24 mm	0.945	0.937	15/16 Inch
	13 mm	0.512	0.500	1/2 Inch		25 mm	0.984	1.00	1 Inch
	15 mm	0.590	0.562	9/16 Inch					

Used with permission of the Dana Corporation, Toledo, Ohio.

INFORMATION SHEET

- B. Select socket with correct point configuration for nut or bolt head it will be used on

(NOTE: Sockets come in six-point configurations, twelve-point configurations, and other special configurations. See Figures 20 and 21.)

EXAMPLES:

FIGURE 20: Six-point socket configuration

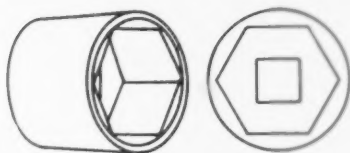
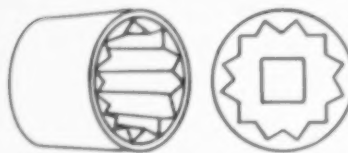


FIGURE 21: Twelve-point socket configuration



- C. Select socket that is correct depth for nut or bolt head it will be used on

(NOTE: Nuts and bolts come with heads of various depths. Sockets come in various depths to accommodate the depth of the nut or bolt head.)

- D. Select socket-wrench handle that matches drive size of socket it will be used with

VII. Types of punches (Figures 22-26)

(NOTE: Punches are used to raise small dents, to punch holes in panels when pulling out dents, and to align holes when assembling body parts.)

- A. Pin punch

FIGURE 22



- B. Starting punch

FIGURE 23



INFORMATION SHEET

C. Drift punch

FIGURE 24



D. Center punch

FIGURE 25



E. Lining-up punch

FIGURE 26



VIII. Types of chisels (Figures 27-30)

(NOTE: Chisels are used to cut metal when removing metal panels, breaking weld joints, and cutting off screws, rivets, or rusted parts.)

A. Cold chisel

FIGURE 27



B. Cape chisel

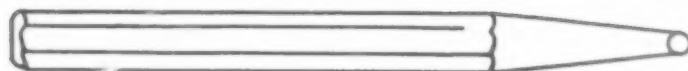
FIGURE 28



INFORMATION SHEET

C. Round-nose chisel

FIGURE 29



D. Diamond-point chisel

FIGURE 30

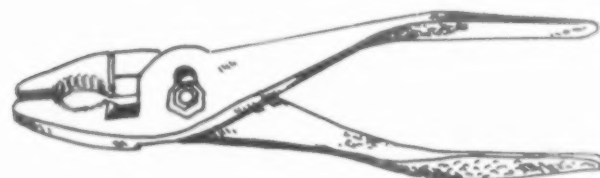


IX. Types of pliers (Figures 31-41)

(NOTE: Pliers are used for gripping, cutting, holding, and many other purposes in the shop.)

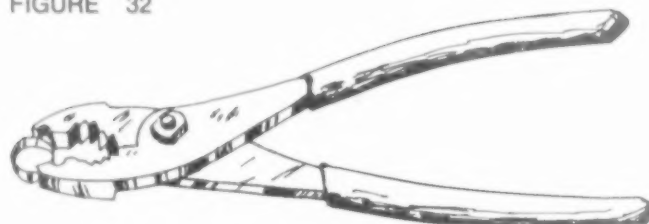
A. Combination pliers

FIGURE 31



B. Hose-clamp pliers

FIGURE 32



INFORMATION SHEET

C. Rib-joint pliers

FIGURE 33



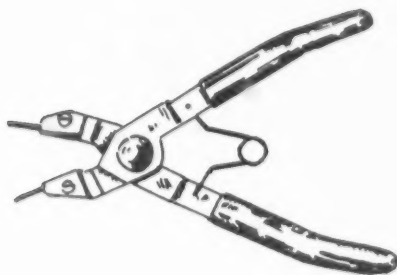
D. Diagonal pliers

FIGURE 34



E. Snap-ring pliers

FIGURE 35



F. Lineman's pliers

FIGURE 36



INFORMATION SHEET

G. Needle-nose pliers

FIGURE 37



H. Standard grip pliers

FIGURE 38



I. Welding-clamp pliers

FIGURE 39



J. Sheet-metal pliers

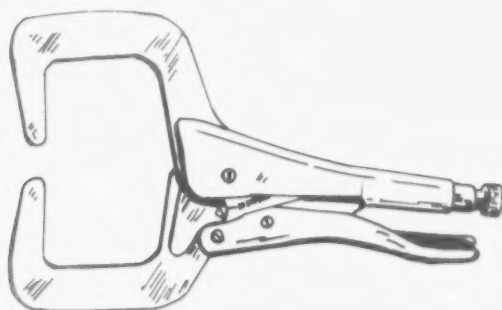
FIGURE 40



INFORMATION SHEET

K. C-clamp pliers

FIGURE 41

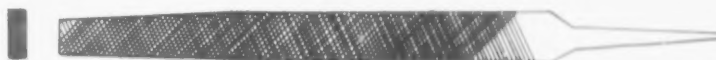


X. Types of general-purpose files (Figures 42-45)

(NOTE: Files are used to smooth and shape surfaces. Files come in various shapes, sizes, and types of cuts.)

A. Flat

FIGURE 42



B. Round

FIGURE 43



C. Half-round

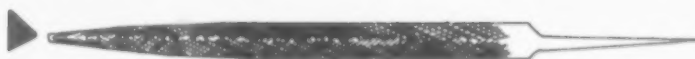
FIGURE 44



INFORMATION SHEET

D. Triangular

FIGURE 45

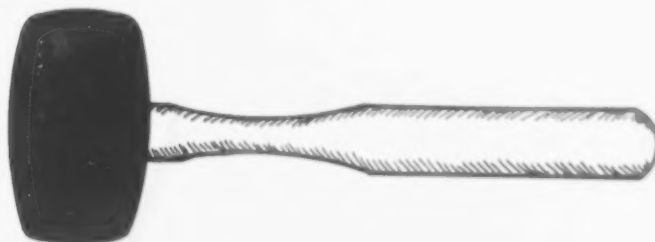


XI. Types of general-purpose hammers (Figures 46-49)

(NOTE: The hammers illustrated are used in general shop work. These hammers come in various weights that are determined by the weight of the hammer **head** only. The weight of the handle has nothing to do with the weight of the hammer.)

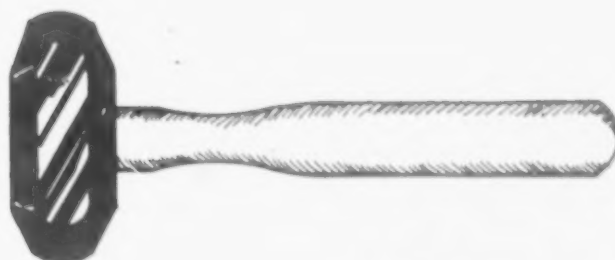
A. Rubber hammer

FIGURE 46



B. Brass hammer

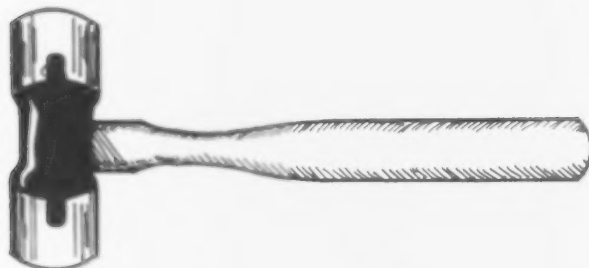
FIGURE 47



INFORMATION SHEET

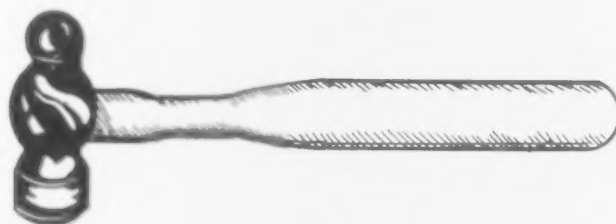
C. Plastic-tipped hammer

FIGURE 48



D. Ball-peen hammer

FIGURE 49



XII. Uses of miscellaneous hand tools (Figures 50-63)

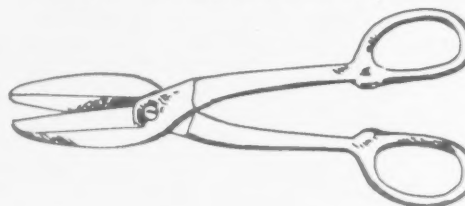
A. Tin snips — Used to cut sheet metal

EXAMPLES:

FIGURE 50: Aviation-type tin snips



FIGURE 51: Standard tin snips



INFORMATION SHEET

- B. Brushes — Used to clean rust, old paint, and other materials from auto-body parts

EXAMPLES:

FIGURE 52: Wire brush



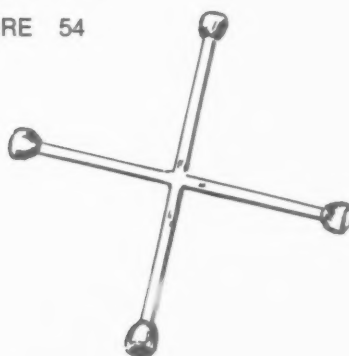
FIGURE 53: Carbon brush



- C. Lug wrench — Used to remove wheel lugs

EXAMPLE:

FIGURE 54



- D. Tap and tap wrench — Used to form an internal thread in metal

EXAMPLES:

FIGURE 55: Tap

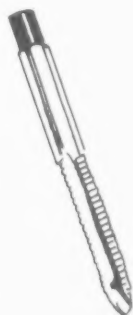
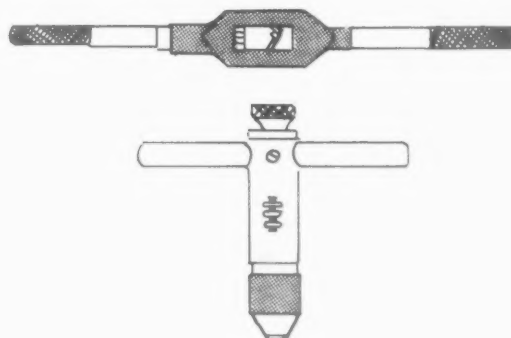


FIGURE 56: Tap wrench



INFORMATION SHEET

- E. Scratch awl — Used to mark metal for cutting, drilling, and fastening, and to pierce holes in thin metal

EXAMPLE:

FIGURE 57



- F. Die and die stock — Used to make threads on nuts and bolts

EXAMPLES:

Figure 58: Die



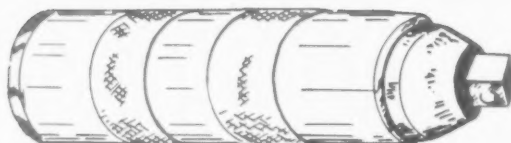
FIGURE 59: Die stock



- G. Impact driver — Used to loosen or tighten nuts and bolts

EXAMPLE:

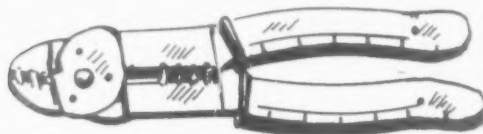
FIGURE 60



- H. Multipurpose electrician's pliers — Used to strip insulation from wires, cut small wires, cut small bolts, and crimp small lugs

EXAMPLE:

FIGURE 61



INFORMATION SHEET

- I. Unibit — Used to drill round holes of various sizes in thin materials such as sheet metal and plastic

EXAMPLE:

FIGURE 62



- J. Screw extractor — Used to remove damaged screws and bolts

EXAMPLE:

FIGURE 63



GENERAL HAND TOOLS
UNIT VII

ASSIGNMENT SHEET #1 — COMPLETE SAFETY TEST FOR HAND TOOLS

NAME _____ SCORE _____

To use hand tools correctly, you must follow the safety rules for the tools.

Treat this assignment sheet as a self-test and do not refer to the information sheet to complete each of the following safety rules for hand tools. Write the missing word or words in the blanks. When you have completed the assignment sheet, exchange it with a class member and grade it. Refer to Information Sheet, Section II for correct answers. Each blank—regardless of the number of words it contains—counts as 10 points. Perfect score is 100 percent.

- A. Use the _____ for the job
- B. Keep cutting tools _____
- C. Keep tools _____
- D. _____ tools frequently to make sure that they are in good condition
- E. _____ of broken or damaged tools that cannot be repaired
- F. _____ tools _____ when not in use
- G. _____ when using tools
- H. Wear appropriate _____

GENERAL HAND TOOLS
UNIT VII

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

- A. Correct tool
- B. Sharp
- C. Clean
- D. Inspect
- E. Dispose
- F. Store, properly
- G. Stay alert
- H. Eye protection

GENERAL HAND TOOLS
UNIT VII

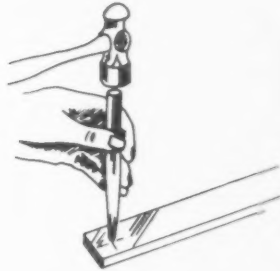
JOB SHEET #1 — HAND TAP A HOLE IN A PIECE OF STEEL

- I. Tools and equipment
 - A. Drill chart
 - B. Bench vise
 - C. Eye protection
 - D. Center punch
 - E. Hammer
 - F. Power drill
 - G. Drill bit
 - H. Tap wrench
 - I. Tap (taper)
 - J. Small square
 - K. Cutting fluid
 - L. Appropriate bolt for checking threads
 - M. Scratch awl
 - N. Piece of scrap steel
- II. Procedure
 - A. Determine size of thread from information given on drill chart
 - B. Select proper tap drill from information given on drill chart
 - C. Put on eye protection
 - D. Mount piece of steel in vise
 - E. Locate center of hole on steel; mark with scratch awl

JOB SHEET #1

F. Use center punch and hammer to make a starting hole (Figure 64)

FIGURE 64

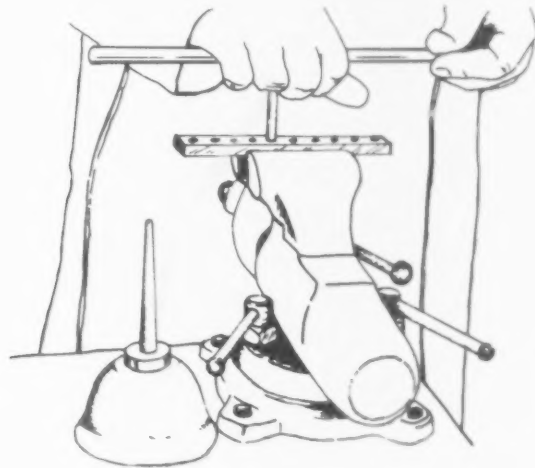


G. Select drill bit of proper size for making hole with power drill

H. Tighten tap in tap wrench

I. Cup hand over tap wrench and place tap in hole in steel; with tap parallel to hole, start turning to right, keeping downward pressure on tap; apply cutting fluid to the tap above the steel as required (Figure 65)

FIGURE 65

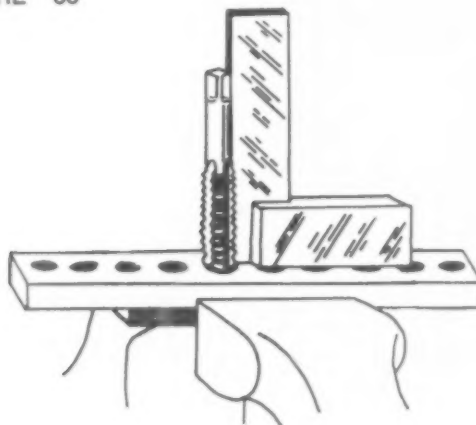


JOB SHEET #1

- J. Remove tap wrench after a few threads have been cut and check for squareness (Figure 66)

(NOTE: Use small square to check for squareness. Tap should be at 90-degree angle from the work in all positions. If tap is not square, you must start over; otherwise the thread and possibly the hole will be ruined.)

FIGURE 66



- K. Reset tap wrench and continue turning and tapping hole until it is necessary to clean chips from hole

(NOTE: When using an ordinary hand tap, after about three turns or when tap gets hard to turn, reverse the tap one turn to break the chips. This will remove the chips and prevent damaging threads and tap. When tapping a blind hole, remove the tap and clean out the hole occasionally; complete the tapping operation with a bottoming tap.)

- L. Check thread with bolt of correct dimensions
- M. Clean work area and return tools and equipment to proper storage

GENERAL HAND TOOLS UNIT VII

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with hand tools. Write the correct numbers in the blanks.

- | | |
|--|------------------|
| _____ a. Nuts or bolts holding vehicle wheels in place | 1. Configuration |
| _____ b. Width of square peg or hole on socket tools | 2. Drive size |
| _____ c. Arrangement of parts | 3. Wheel lugs |
| _____ d. Turning or twisting force | 4. Torque |

2. State five rules for care and safe use of hand tools.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

3. Label the types of screwdrivers illustrated.



- a. _____



- b. _____

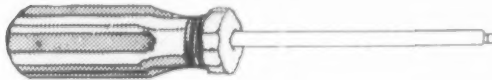
TEST



c. _____



d. _____



e. _____

4. State guidelines for selecting the correct standard screwdriver for the job.

a. _____

b. _____

5. Identify the types of wrenches illustrated. Write the correct names in the blanks.

Open-end wrench
Adjustable wrench

Box-end wrench
Socket-wrench set

Combination-end wrench

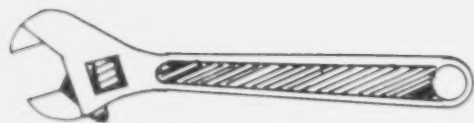


a. _____



b. _____

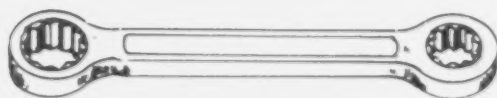
TEST



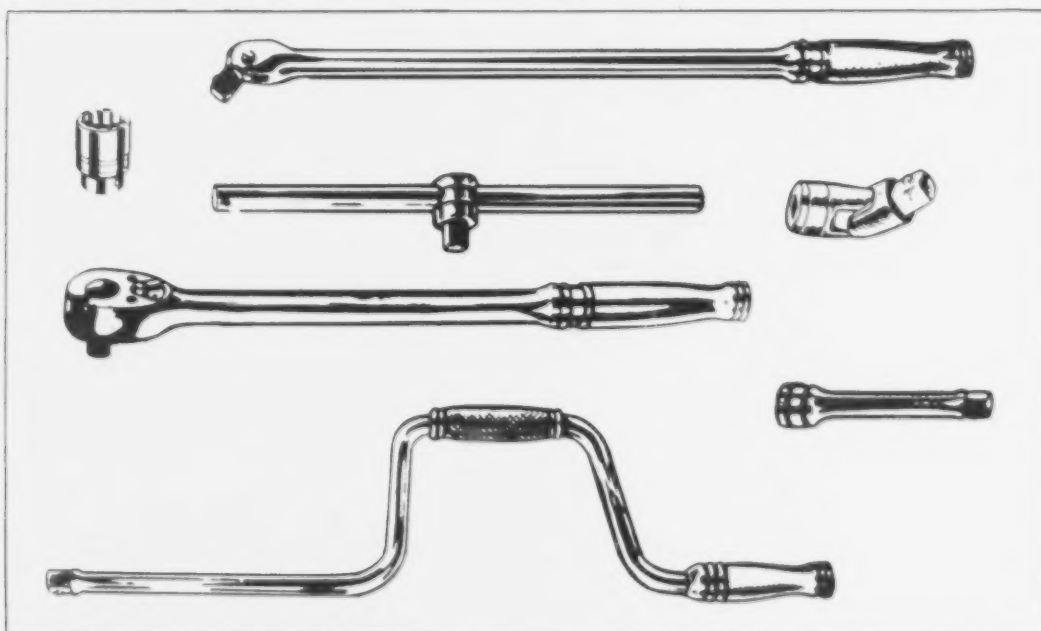
c. _____



d. _____



e. _____



f. _____

TEST

6. State guidelines for selecting the correct socket and handle for the job.

- a. _____

- b. _____

- c. _____

- d. _____

7. Identify the types of punches illustrated. Write the correct names in the blanks.

Pin punch
Center punch

Starting punch
Lining-up punch

Drift punch



a. _____



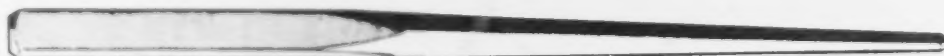
b. _____



c. _____



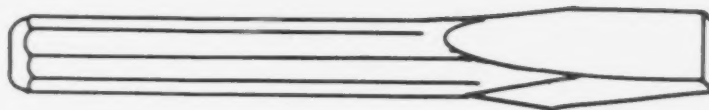
d. _____



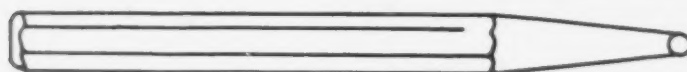
e. _____

TEST

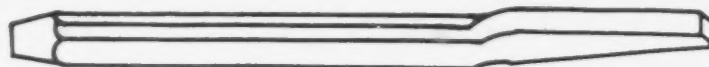
8. Label the types of chisels illustrated.



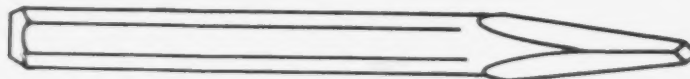
a. _____



b. _____



c. _____



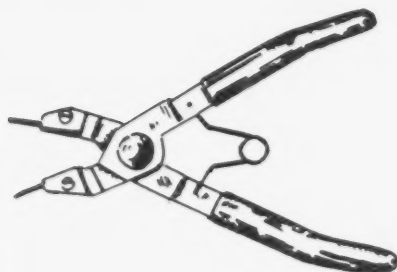
d. _____

9. Identify the types of pliers illustrated. Write the correct names in the blanks.

Combination pliers
Hose-clamp pliers
Rib-joint pliers
Snap-ring pliers

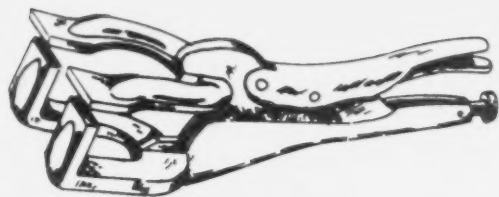
Diagonal pliers
Lineman's pliers
Needle-nose pliers
Standard grip pliers

Welding-clamp pliers
Sheet-metal pliers
C-clamp pliers



a. _____

TEST



b. _____



c. _____



d. _____



e. _____



f. _____

TEST



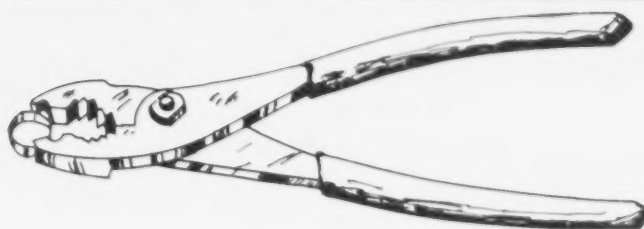
g. _____



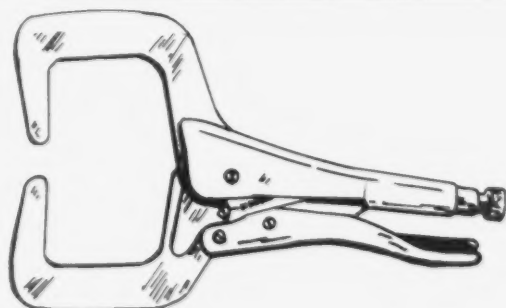
h. _____



i. _____



j. _____



k. _____

TEST

10. Label the types of general-purpose files illustrated.



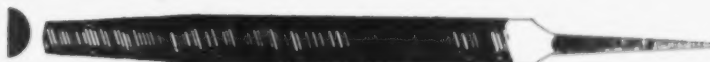
a. _____



b. _____



c. _____



d. _____

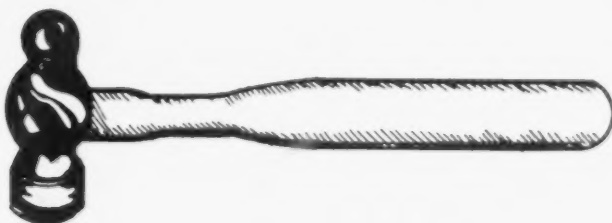
11. Identify the types of general-purpose hammers illustrated. Write the correct names in the blanks.

Rubber hammer

Brass hammer

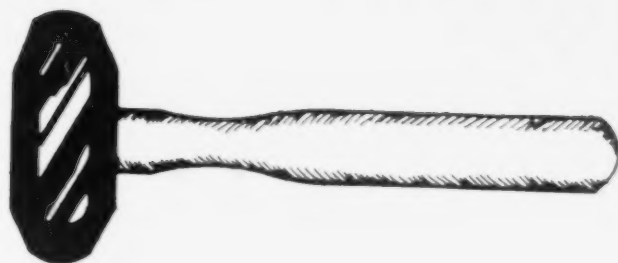
Plastic-tipped hammer

Ball-peen hammer



a. _____

TEST



b. _____



c. _____



d. _____

TEST

12. Match types of miscellaneous hand tools to their correct uses. Write the correct numbers in the blanks.

- | | |
|--|--------------------------------------|
| _____a. Used to mark metal for cutting, drilling, and fastening, and to pierce holes in thin metal | 1. Tin snips |
| _____b. Used to make threads on nuts and bolts | 2. Brushes |
| _____c. Used to clean rust, old paint, and other materials from auto-body parts | 3. Lug wrench |
| _____d. Used to loosen or tighten nuts and bolts | 4. Tap and tap wrench |
| _____e. Used to cut sheet metal | 5. Scratch awl |
| _____f. Used to remove wheel lugs | 6. Impact driver |
| _____g. Used to form an internal thread in metal | 7. Die and die stock |
| _____h. Used to strip insulation from wires, cut small wires, cut small bolts, and crimp small lugs | 8. Multipurpose electrician's pliers |
| _____i. Used to drill round holes of various sizes in thin materials such as sheet metal and plastic | 9. Unibit |
| _____j. Used to remove damaged screws and bolts | 10. Screw extractor |

(NOTE: Test question 13 lists the job sheet. It is an important part of the test. If it has not been completed, check with your instructor.)

13. Demonstrate the ability to hand tap a hole in a piece of steel.

GENERAL HAND TOOLS
UNIT VII

ANSWERS TO TEST

1. a. 3 c. 1
 b. 2 d. 4
2. Answer should include any five of the following
 - a. Wear appropriate eye protection
 - b. Use the correct tool for the job
 - c. Keep cutting tools sharp
 - d. Keep tools clean
 - e. Inspect tools frequently to make sure that they are in good condition
 - f. Dispose of broken or damaged tools that cannot be repaired
 - g. Store tools properly when not in use
 - h. Stay alert when using tools
3. a. Phillips screwdriver d. Reed and Prince screwdriver
 b. Standard screwdriver (straight-blade screwdriver) e. Torx screwdriver
 c. Clutch screwdriver
4. a. Select screwdriver with blade the same size as screw slot it will be used on
 b. Select screwdriver that has a hollow-ground blade
5. a. Combination-end wrench d. Open-end wrench
 b. Box-end wrench e. Ratchet wrench
 c. Adjustable wrench f. Socket-wrench set
6. a. Select socket that is same size as nut or bolt head it will be used on
 b. Select socket with correct point configuration for nut or bolt head it will be used on
 c. Select socket that is correct depth for nut or bolt head it will be used on
 d. Select socket-wrench handle that matches drive size of socket it will be used with
7. a. Lining-up punch d. Starting punch
 b. Pin punch e. Drift punch
 c. Center punch
8. a. Cold chisel c. Cape chisel
 b. Round-nose chisel d. Diamond-point chisel

ANSWERS TO TEST

9. a. Snap-ring pliers
b. Welding-clamp pliers
c. Diagonal pliers
d. Needle-nose pliers
e. Combination pliers
f. Standard grip pliers
g. Lineman's pliers
h. Sheet-metal pliers
i. Rib-joint pliers
j. Hose-clamp pliers
k. C-clamp pliers
10. a. Triangular
b. Flat
c. Round
d. Half-round
11. a. Ball-peen hammer
b. Brass hammer
c. Rubber hammer
d. Plastic-tipped hammer
12. a. 5
b. 7
c. 2
d. 6
e. 1
f. 3
g. 4
h. 8
i. 9
j. 10
13. Performance skills evaluated to the satisfaction of the instructor

BODY AND REFINISHING EQUIPMENT UNIT VIII

UNIT OBJECTIVE

After completing this unit, the student be able to identify body and refinishing equipment and match the equipment to their correct uses. The student should also be able to state rules for the safe use and proper care of the equipment. The student will show this knowledge by completing assignment sheet, job sheet, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with body and refinishing equipment.

Body equipment

2. State rules for care and safe use of hand tools used for body work.
3. Match to their correct descriptions hand tools used for body straightening.
4. Identify hand tools used for body filling and shaping.
5. Identify hand tools used for special body work.
6. State rules for safe use of power tools used for body work.
7. State guidelines for proper care of power tools used for body work.
8. Match to their correct uses hand-operated power tools used for body work.
9. Match to their correct uses portable and stationary power equipment used for body work.

Refinishing equipment

10. State rules for safe use of refinishing equipment.
11. Match types of refinishing equipment to their correct uses.
12. Complete safety test for body and refinishing equipment.
13. Demonstrate the ability to use a bench grinder to dress a cold chisel.

BODY AND REFINISHING EQUIPMENT
UNIT VIII

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Assignment Sheet #1 — Complete Safety Test for Body and Refinishing Equipment
- E. Answers to assignment sheet
- F. Job Sheet #1 — Use a Bench Grinder to Dress a Cold Chisel
- G. Test
- H. Answers to test

II. Instructor's guide

A. Order or obtain materials to supplement unit.

1. Filmstrips

- a. *Tool Identification*, 1 cassette, 1 filmstrip (41 frames), 1 work sheet
- b. *Auto Body Hand Tools*, 1 cassette, 1 filmstrip
- c. *Auto Body Power Tools*, 1 cassette, 1 filmstrip

(NOTE: The filmstrips listed above describe basic auto-body tools and their uses, discuss selection of the proper tool for the job, and stress proper set-up and safe use of both hand and power tools. These filmstrips are available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628.)

- 2. Newspaper clippings or case studies that relate to safe use of hand tools, power tools, and refinishing equipment
- 3. Manufacturer's instruction manual for power tools discussed in this unit
- 4. Copies of safety-pledge forms that appear in Unit II, "Safety and Basic First Aid"
- 5. Equipment and materials for job sheet procedures
- 6. Competency profiles

SUGGESTED ACTIVITIES

(NOTE: Competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

B. Review unit and plan presentation.

(NOTE: This unit has been designed to allow you a great deal of flexibility in presenting the material. In the information sheet, the safety rules for hand tools are given before the objectives relating to hand tools, the safety rules for power tools are given before the objectives relating to power tools, and the safety rules for refinishing equipment are given before the objective relating to refinishing equipment. The safety-test assignment sheet and the unit test can be given in parts to cover just one group of tools or equipment at a time. You will want to consider your students, your program, the time available, your shop facilities, and other factors in making presentation decisions.)

C. Introduce unit.

SUGGESTIONS:

- Show filmstrip *Tool Identification*. Make copies of and have students complete the work sheet that accompanies this filmstrip.
 - Take students on a tour of the shop, pointing out hand tools used for body straightening, body filling and shaping, and special body work. Emphasize the correct use for each tool.
 - Take students on a tour of the shop and point out the refinishing equipment and power tools available in your shop. Emphasize the correct use for each piece of equipment.
 - Discuss the correct uses of any types of body and refinishing equipment that are used in your shop. Emphasize the correct use for each piece of equipment.
 - Display newspaper clippings or case studies that relate to safe use of hand tools, power tools, and refinishing equipment. Discuss these with your students.
- D. Provide students with objective sheet. Discuss unit and specific objectives, pointing out that the safety material in this unit is important enough to require a perfect score on the safety sections of the unit test.
- E. Provide students with information, assignment, and job sheets.
- F. Discuss information, assignment, and job sheets.
1. Use Information Sheet, Section I to introduce terms associated with body and refinishing equipment.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Take students to the rough-out area of the shop and demonstrate or point out the terms *roughing out*, *bumping*, *shrinking*, *spring-hammering*, and *unibody*.
 - Take students to the refinishing area of the shop and demonstrate the terms *featheredging* and *paint atomizing*.
2. Use Information Sheet, Section II to discuss rules for care and safe use of hand tools used for body work.

SUGGESTIONS:

- Explain your policy for replacement of damaged hand tools.
 - Outline your tool management policy for the shop.
 - Explain to students the importance of wearing eye protection, and discuss procedures that require eye protection.
 - Have students complete Part I of Assignment Sheet #1.
3. Use Information Sheet, Section III to introduce students to hand tools used for body straightening.

SUGGESTIONS:

- Show filmstrip *Auto Body Hand Tools*.
 - Show students samples of the various hand tools illustrated in this section of the information sheet. Discuss the correct use of each tool and allow students to examine each tool.
4. Use Information Sheet, Section IV to discuss hand tools used for body filling and shaping.

SUGGESTIONS:

- Show students samples of various hand tools illustrated in this section of the information sheet. Discuss the correct use of each tool, and allow students to examine each tool.
 - Demonstrate correct methods for mixing and shaping plastic filler with the tools illustrated in this section of the information sheet.
5. Use Information Sheet, Section V to discuss hand tools used for special body work.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Show students samples of the various hand tools illustrated in this section of the information sheet. Discuss the correct use of each tool, and allow students to examine each tool.
 - Display tools on a table and have students identify tools.
6. Use Information Sheet, Sections VI and VII to discuss rules for safe use and proper care of power tools used for body work.

SUGGESTIONS:

- Emphasize the convenience of power tools while stressing the fact that the use of power tools places on the student an even greater responsibility to be careful.
- Explain your policy for student use of power tools.

(NOTE: We recommend that students pass a safety test on each power tool and have a signed safety-pledge form on file before being allowed to operate a power tool.)

- Explain to students the importance of wearing eye protection, and remind students that they must *always* wear eye protection when operating power tools.
 - Have students complete Parts II and III of Assignment Sheet #1.
7. Use Information Sheet, Section VIII to discuss hand-operated power tools used for body work.

SUGGESTIONS:

- Show filmstrip *Auto Body Power Tools*.
 - Show students samples of the various power tools illustrated in this section of the information sheet and demonstrate the correct use of each tool. Allow students to examine each power tool.
 - Have students review manufacturer's instruction manual for each power tool.
 - Explain that when power tools are used incorrectly they may damage the vehicle as well as cause personal injury.
8. Use Information Sheet, Section IX to discuss portable and stationary power equipment used for body work.

SUGGESTIONS:

- Take students on a tour of the shop and show them the power tools illustrated in this section of the information sheet. Demonstrate the correct use of each tool.

SUGGESTED ACTIVITIES

- Have students review manufacturer's instruction manual for each power tool.
9. Use Information Sheet, Section X to discuss rules for safe use of refinishing equipment.

SUGGESTIONS:

- Explain your policy for student use of refinishing equipment.
 - Explain to students the importance of wearing safety equipment and discuss procedures that require the use of safety equipment.
 - Have students complete Part IV of Assignment Sheet #1.
10. Use Information Sheet, Section XI to discuss types of refinishing equipment.

SUGGESTIONS:

- Take students to the refinishing area of the shop and show them the equipment illustrated in this section of the information sheet. Demonstrate the correct use of each piece of equipment.
- Have students review the manufacturer's instruction manual for each piece of equipment.

G. Review information.

H. Give test and critique in class.

I. Complete appropriate section of competency profiles.

III. Unit references

- A. *Automotive Technology 1985 Catalog*. Costa Mesa, California: Teaching Aids, Incorporated, 1985.
- B. Hobson, W. T. *Automotive Refinish Principles and Techniques*, 1st ed. Wilmington, Delaware: E. T. dePont de Nemours and Co., 1969.
- C. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.
- D. MacPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Inc., 1971.
- E. Spicer, Edward D. *Automotive Collision Work*, 4th ed. Chicago, Illinois: American Technical Society, 1972.
- F. Toboldt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

BODY AND REFINISHING EQUIPMENT
UNIT VIII

INFORMATION SHEET

- I. Terms associated with body and refinishing equipment
- A. Roughing out — Straightening auto body's inner construction or reinforcement and roughly reshaping damaged outer sheet metal
 - B. Bumping — Leveling and smoothing sheet metal that has already been roughed out, restoring it as close to its original shape as possible
 - C. Shrinking — Contracting expanded sheet metal back to its original size and shape
 - D. Spring-hammering — Straightening ridges and other high surfaces in sheet metal
 - E. Featheredging — Tapering rough edges of paint or body filler
 - F. Atomize — To break liquid into tiny droplets
 - G. Unibody — Body design in which body and frame are combined into one unit

Body equipment

- II. Rules for care and safe use of hand tools used for body work
- A. Use the correct tool for the job
 - B. Keep tools clean
 - C. Inspect tools frequently to make sure that they are in good condition
 - D. Dispose of broken or damaged tools that cannot be repaired
 - E. Store tools properly when not in use

EXAMPLES: Do not carry tools in your pockets; do not place tools on workbench where they can roll off; protect cutting edges; lightly oil tools before storing; store tools in a dry place.

- F. Stay alert when using tools

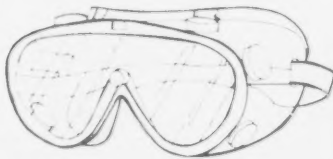
EXAMPLES: Keep fingers away from cutting edges; work away from your body when using cutting tools.

INFORMATION SHEET

G. Wear appropriate eye protection when necessary (Figures 1-5)

EXAMPLES:

FIGURE 1: Goggles



FIGURES 2: Safety glasses

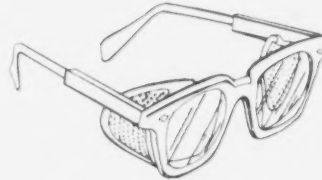


FIGURE 3: Welding goggles

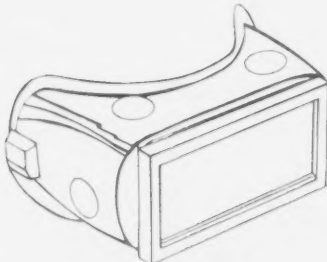


FIGURE 4: Safety shield

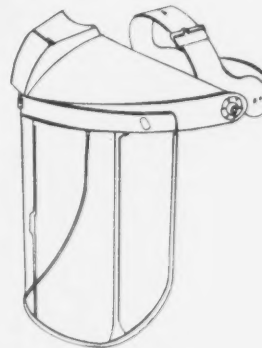


FIGURE 5: Arc-welding helmet



III. Descriptions of hand tools used for body straightening

A. Hammers (Figures 6-11)

(NOTE: Many different types of body-work hammers are available today, and each hammer is designed for a specific purpose. It is important that you be able to identify and select the right hammer for the job.)

INFORMATION SHEET

1. Shrinking hammer — Metal hammer with two flat, serrated faces; used with various shapes of dollies for repairing slightly stretched metal

EXAMPLE:

FIGURE 6



2. Bumping hammer — Metal hammer with a round face and a square face; used for finishing and light shrinking

EXAMPLE:

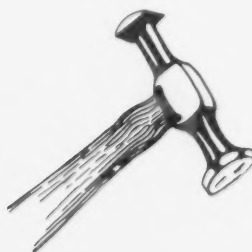
FIGURE 7



3. Dinging hammer — A light bumping hammer with two round faces; used alone for roughing and with a dolly for shrinking

EXAMPLE:

FIGURE 8

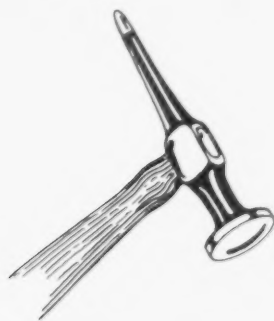


INFORMATION SHEET

4. Pick hammer — Metal hammer with a smooth, round face and a sharp end; smooth face is used alone for working down high spots and with a dolly for working metal down; sharp end is used for picking up small dents

EXAMPLE:

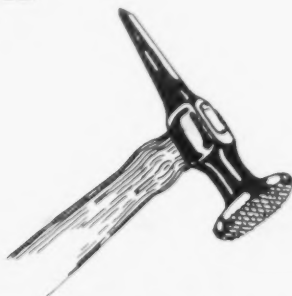
FIGURE 9



5. Cross-peen hammer — Combination hammer that has a flat, serrated end and a sharp end; used for shrinking and for picking up small dents

EXAMPLE:

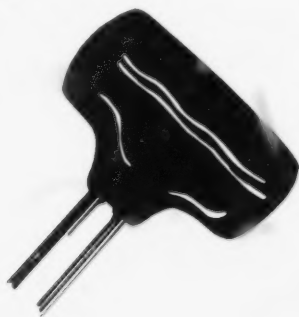
FIGURE 10



6. Dead-blow hammer — Soft hammer with metal shot inside head to prevent rebound; used for straightening metal when great striking force is needed

EXAMPLE:

FIGURE 11



INFORMATION SHEET

B. Dollies — Small, variously shaped hand anvils made of high-grade steel; used as back-up tools in roughing and bumping (Figures 12-18)

EXAMPLES:

FIGURE 12: Anvil dolly

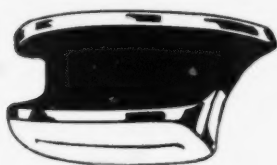


FIGURE 13: General-purpose dolly (railroad dolly)

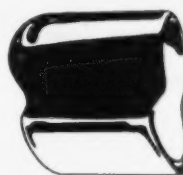


FIGURE 14: Utility dolly



FIGURE 15: Toe dolly



FIGURE 16: Heel dolly

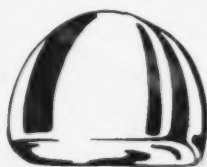


FIGURE 17: Heavyweight dolly



FIGURE 18: Comma dolly (wedge dolly)



INFORMATION SHEET

- C. Spoons — Small tools that come in various shapes and sizes; used alone for prying out dents in restricted, confined areas and with a hammer for spring-hammering (Figures 19-22)

EXAMPLES:

FIGURE 19: Backup and driving spoon



FIGURE 20: Bumping file (slapping file)



FIGURE 21: Spoon dolly

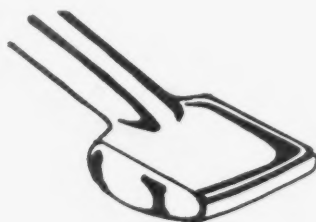
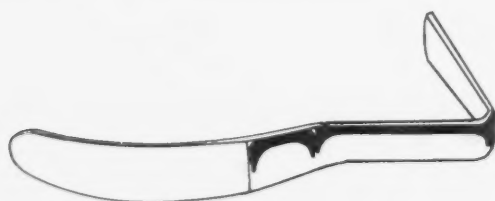


FIGURE 22: Spring-hammering spoon



INFORMATION SHEET

- D. Body files — Holder and blade used for working down very small high places after the damaged area has been aligned and dollyed almost to original contour (Figures 23-26)

(NOTE: File holders come in two styles: straight and flexible. File blades come in three shapes: straight, curved, and round. Blades are usually single-cut; teeth are curved with u-shaped grooves between teeth that allow shavings to escape and prevent plugging.)

EXAMPLES:

FIGURE 23: Straight file holder



FIGURE 24: Flexible file holder

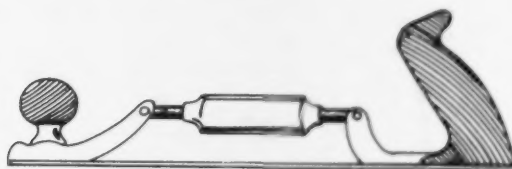


FIGURE 25: Straight blade



FIGURE 26: Curved blade



INFORMATION SHEET

- E. Pick — Tool with a pointed end and a turning handle; used for forcing out and bringing up small damaged or low areas (Figures 27 and 28)

EXAMPLES:

FIGURE 27: Curved short pick



FIGURE 28: Curved long pick



F. Miscellaneous body-straightening hand tools

1. Slide hammer — Tool consisting of a metal shaft on which a handle and a sliding weight are mounted; used with a large sheet-metal screw for pulling out dents in metal (Figure 29)

(NOTE: The slide hammer may also be used with pull tabs welded to the metal surface as opposed to drilling holes for sheet-metal screws.)

EXAMPLE:

FIGURE 29

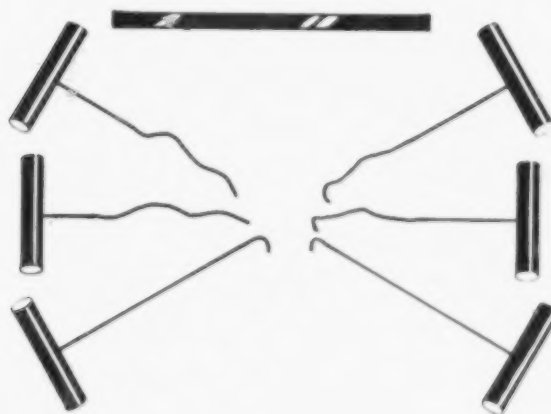


INFORMATION SHEET

2. Pull rod — Long, thin tool with a hook on one end and a handle on other end; hook is inserted into a hole in metal and used for pulling out shallow dents (Figure 30)

EXAMPLE:

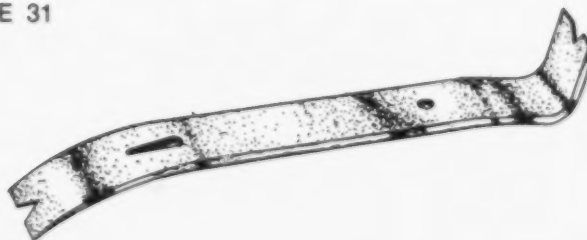
FIGURE 30: Pull rod set



3. Pry bar — All-purpose tool with curved and slotted ends; used as a lever (Figure 31)

EXAMPLE:

FIGURE 31



INFORMATION SHEET

4. Metal shears — Plierlike tool with serrated blades; used for cutting metal patches and for cutting out pieces of metal that cannot be repaired (Figure 32)

EXAMPLE:

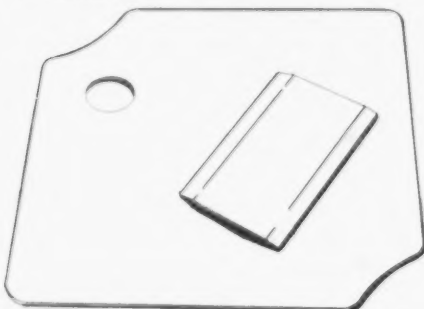
FIGURE 32



IV. Hand tools used for body filling and shaping (Figures 33-36)

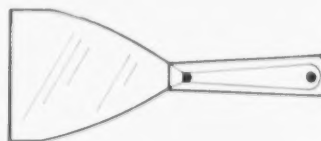
A. Mixing board and spreader

FIGURE 33



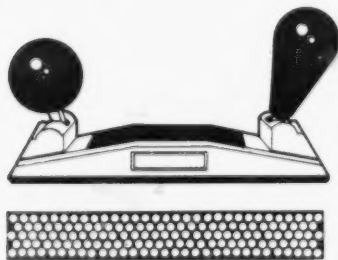
B. Putty knife

FIGURE 34



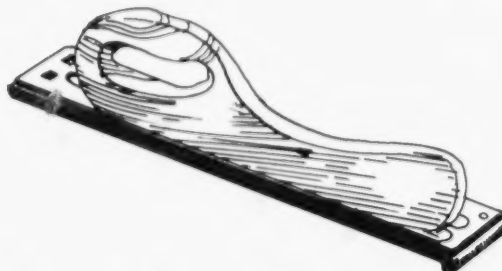
C. Plastic-shaping file

FIGURE 35



D. Plastic-finishing board file

FIGURE 36

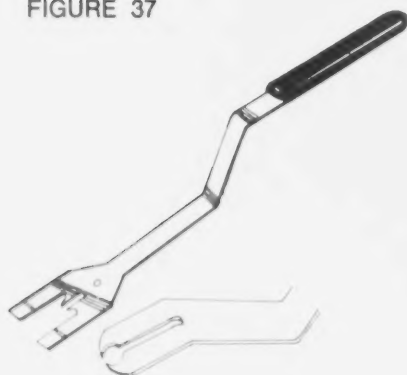


INFORMATION SHEET

V. Hand tools used for special body work (Figures 37-45)

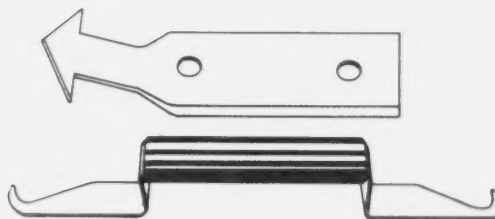
A. Door and window handle-clip remover

FIGURE 37



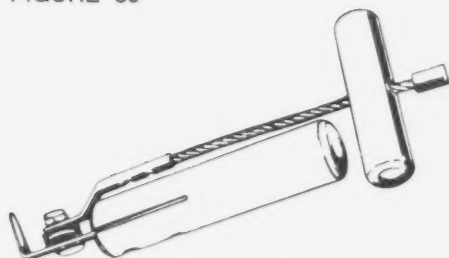
B. Reveal-molding clip tool

FIGURE 38



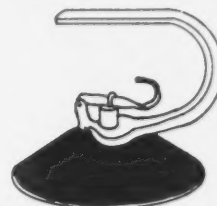
C. Windshield knife

FIGURE 39



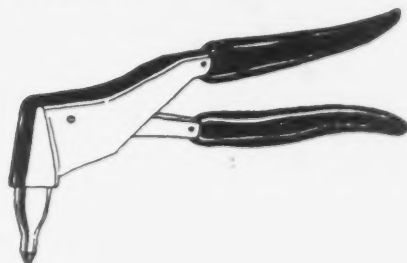
D. Vacuum lifter

FIGURE 40



E. Pop-rivet gun

FIGURE 41



F. Locking-strip tool

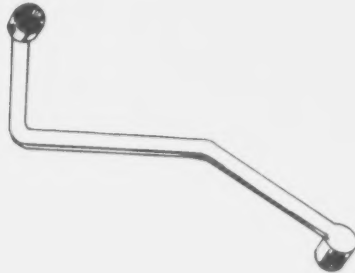
FIGURE 42



INFORMATION SHEET

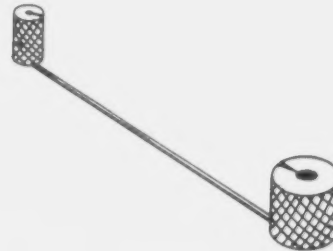
G. Door-hinge wrench

FIGURE 43



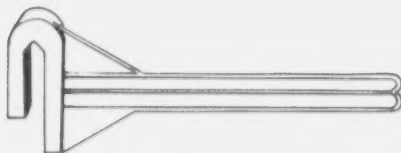
H. Door-hinge aligner

FIGURE 44



I. Bumper-bracket tool

FIGURE 45



VI. Rules for safe use of power tools used for body work

(NOTE: Power tools can be operated by hydraulic, pneumatic, or electric power.)

- A. Do not attempt to operate any power tool before being checked out by the instructor on that particular tool
- B. Always wear eye protection when operating a power tool
- C. Wear appropriate clothing for job being done

(NOTE: Always wear tight-fitting clothing that cannot become caught in the moving tool. Roll up long sleeves, tuck in shirttails, and tie back long hair.)

- D. Do not distract others or let anyone distract you while operating a power tool
- E. Do not leave power tool running unattended
- F. Assume a safe and comfortable position before using a power tool
- G. Be sure that electrical power tool is properly grounded before using

INFORMATION SHEET

- H. Be sure that power tool is disconnected before performing maintenance or changing accessories
 - I. Do not use dull or broken tool or accessories
 - J. Use a power tool only for its intended use
 - K. Keep feet, fingers, and hair away from blade and other moving parts of a power tool
 - L. Do not use a power tool with guards or safety devices removed
 - M. Do not operate a power tool if hands or feet are wet
 - N. Keep work area clean at all times
 - O. Before attempting to use it, be familiar with the correct operation and adjustments of power tool
 - P. Keep a firm grip on the power tool at all times
 - Q. Use electric extension cords and air hoses of sufficient size to service particular power tool you are using
- VII. Guidelines for proper care of power tools used for body work
- A. Keep tools clean and in good working order
 - B. Keep machine surfaces clean and in good working order
 - C. Follow manufacturer's maintenance procedures
 - D. Protect cutting edges
 - E. Keep all tool accessories, such as blades and bits, sharp
 - F. Report any unusual noises, sounds, or vibrations to the instructor
 - G. Inspect tools and accessories regularly
 - H. Store tools in their proper place when not in use

INFORMATION SHEET

VIII. Uses of hand-operated power tools used for body work

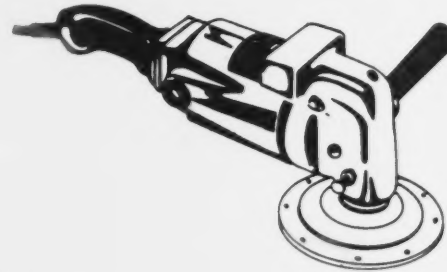
- A. Grinder — Used to remove paint, to buff and grind metal, and to grind welds (Figures 46 and 47)

EXAMPLES:

FIGURE 46: Pneumatic grinder



FIGURE 47: Electric grinder



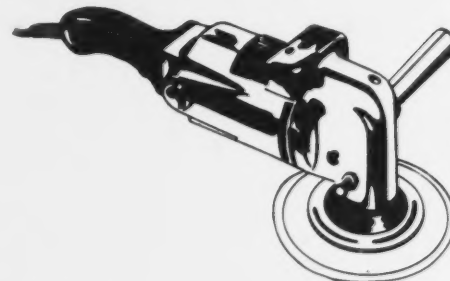
- B. Polisher — Used to polish paint (Figures 48 and 49)

EXAMPLES:

FIGURE 48: Pneumatic polisher



FIGURE 49: Electric polisher



- C. Drill — Used to drill and bore; used with wire-brush attachment to clean metal (Figures 50-52)

EXAMPLES:

FIGURE 50: Pneumatic drill

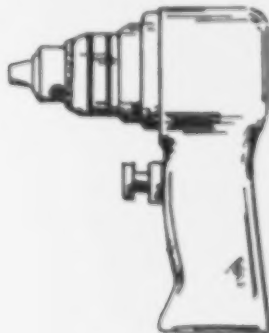
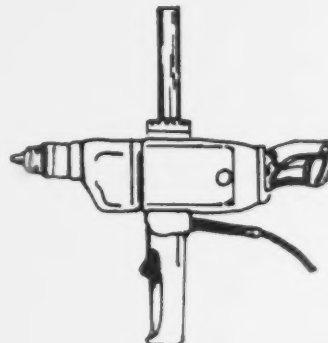
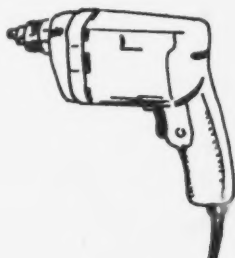


FIGURE 51: One-half-inch electric drill



INFORMATION SHEET

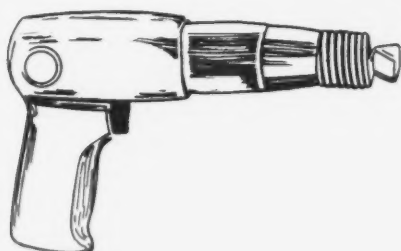
FIGURE 52: One-fourth-inch electric drill



D. Pneumatic hammer — Used to cut spot welds, remove panels, chisel, and rivet (Figure 53)

EXAMPLE:

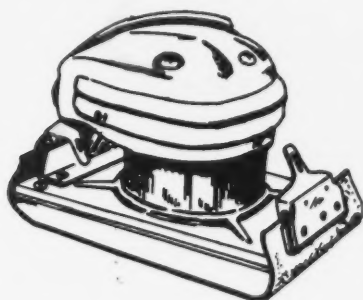
FIGURE 53



E. Orbital sander — Used to smooth metal and to sand and featheredge paint (Figure 54)

EXAMPLE:

FIGURE 54

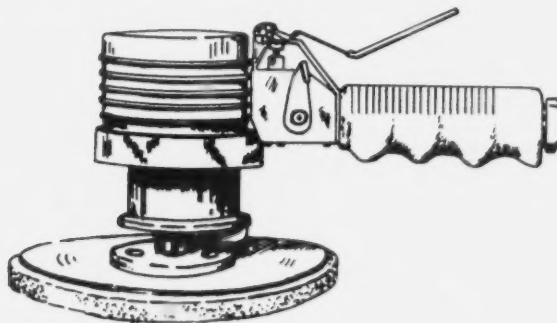


INFORMATION SHEET

- F. Oscillating sander — Used to sand and featheredge paint and to rough-shape plastic body filler (Figure 55)

EXAMPLE:

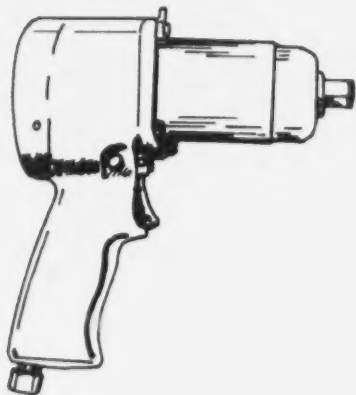
FIGURE 55: Pneumatic oscillating sander



- G. Impact wrench — Used to loosen and tighten bolts (Figure 56)

EXAMPLE:

FIGURE 56

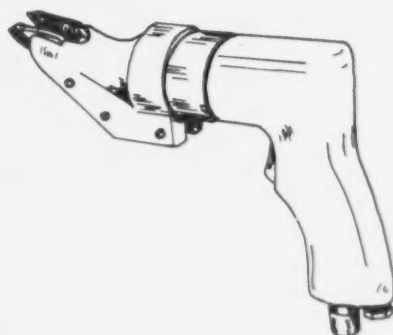


INFORMATION SHEET

H. Power metal shear — Used to cut sheet metal (Figure 57)

EXAMPLE:

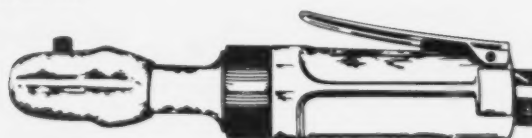
FIGURE 57



I. Pneumatic ratchet — Used to tighten and loosen nuts and bolts (Figure 58)

EXAMPLE:

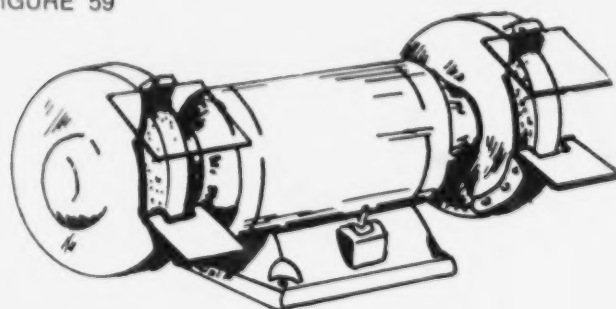
FIGURE 58



J. Bench grinder — Used to dress punches and chisels, to sharpen drill bits, and to grind metal (Figure 59)

EXAMPLE:

FIGURE 59

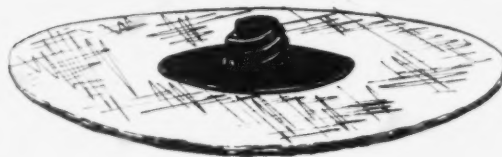


INFORMATION SHEET

- K. Roloc disc — Used to rough out or shape body filler and to grind close areas such as on door posts or around windows (Figure 60)

EXAMPLE:

FIGURE 60

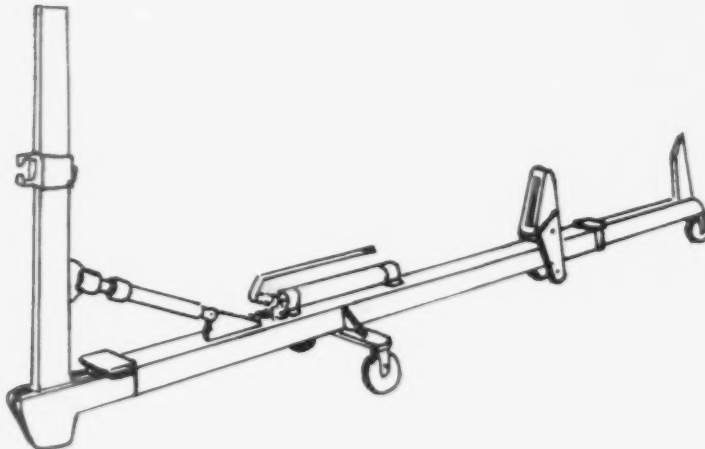


- IX. Uses of portable and stationary power equipment used for body work

- A. Frame- and panel-straightening equipment — Used to align body parts and to align and straighten frame and unibody (Figures 61-65)

EXAMPLES:

FIGURE 61: Portable frame- and body-straightening unit



INFORMATION SHEET

FIGURE 62: Stationary frame- and body-straightening rack

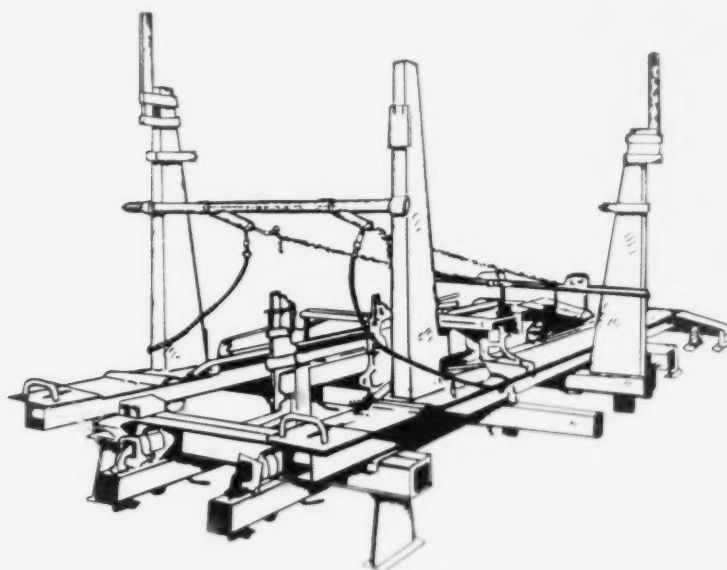
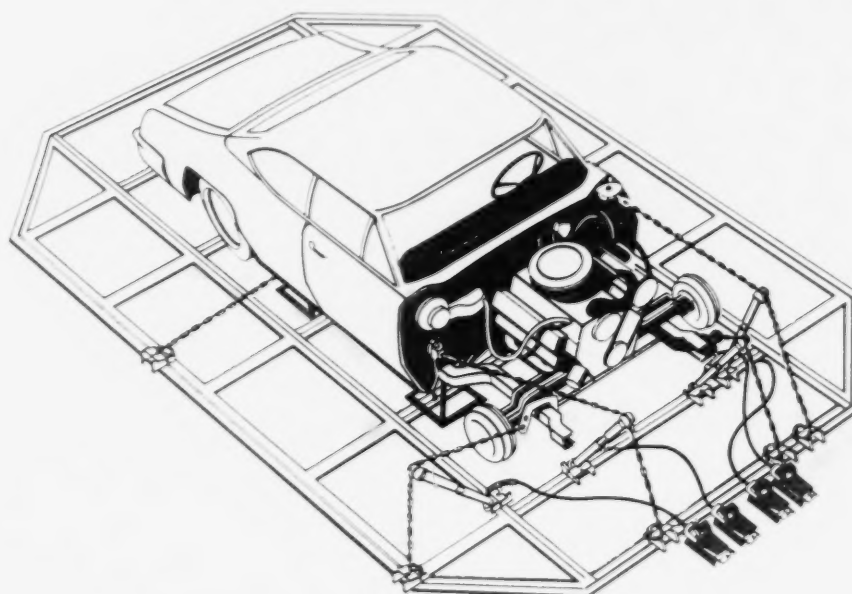


FIGURE 63: Channel-mount frame- and body-straightening unit



INFORMATION SHEET

FIGURE 64: Tie-down with pull post body- and frame-straightening system

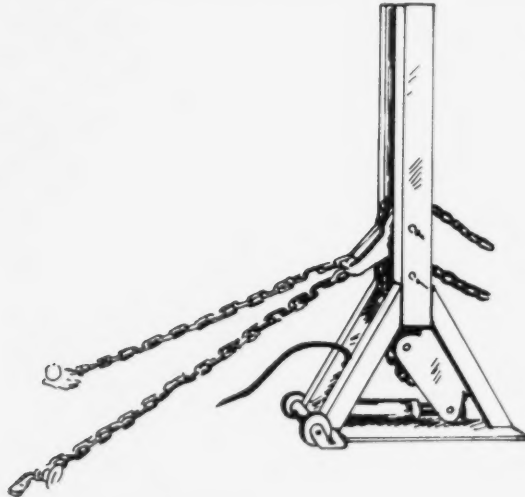
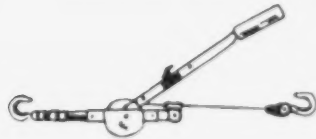


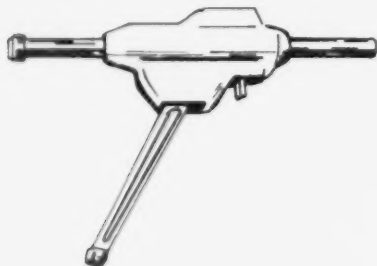
FIGURE 65: Cable pull unit



B. Body jacks and accessories — Used to align body parts, to straighten frame members, and to align unibody and unibody members (Figures 66-70)

EXAMPLES:

FIGURE 66: Mechanical body jack



INFORMATION SHEET

FIGURE 67: Hydraulic body jack set

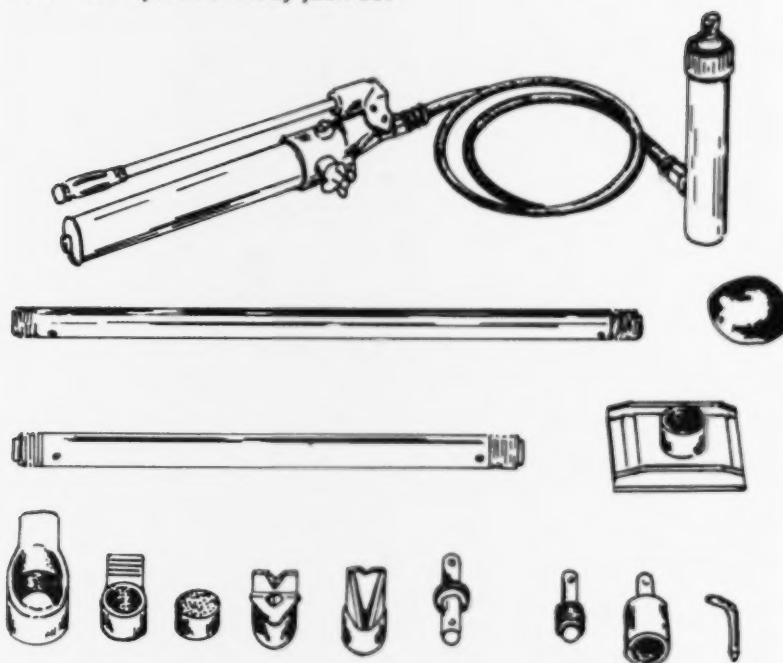


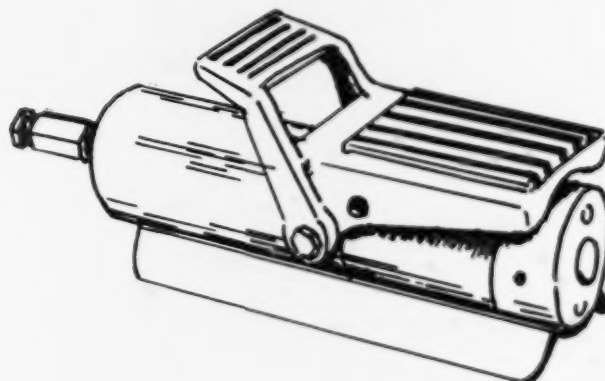
FIGURE 68: Wedge ram



FIGURE 69: Spread ram



FIGURE 70: Pneumatic hydraulic pump



INFORMATION SHEET

- C. Floor jacks and lifts — Used to raise vehicle to gain access to underside (Figures 71-73)

EXAMPLES:

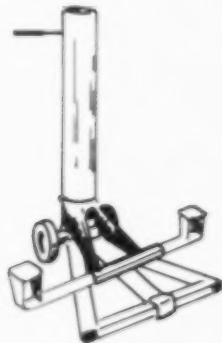
FIGURE 71: Service jack



FIGURE 72: Hand jack



FIGURE 73: One-end lift



- D. Safety stand — Used to secure lifted vehicle so that vehicle will be safe to work under (Figure 74)

EXAMPLE:

FIGURE 74



INFORMATION SHEET

- E. Vacuum cleaner — Used to pick up dirt and dust; some types are used to pick up liquids (Figures 75 and 76)

EXAMPLES:

FIGURE 75: Dry vac



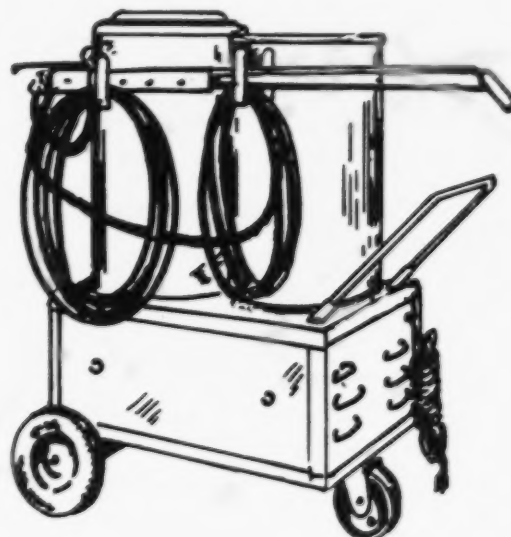
FIGURE 76: Wet vac



- F. Car wash and steam-cleaning system — Used to clean vehicle, engine, and underbody (Figure 77)

EXAMPLE:

FIGURE 77

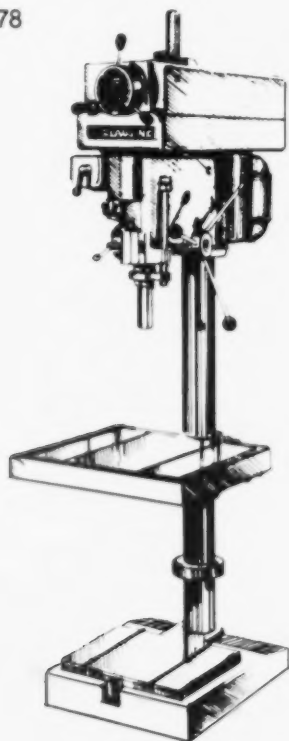


INFORMATION SHEET

G. Drill press — Used to drill and bore holes (Figure 78)

EXAMPLE:

FIGURE 78



H. Welder — Used to connect frame members and rails, to connect body panels, and to spot weld (Figures 79 and 80)

EXAMPLES:

FIGURE 79: AC/DC arc welder (SMAW)

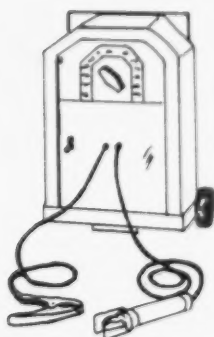
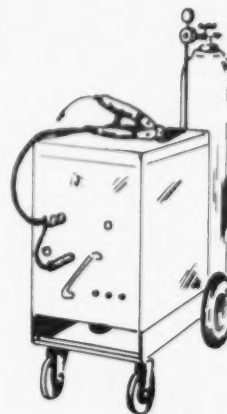


FIGURE 80: GMAW: Gas metal arc welder (MIG)



INFORMATION SHEET

Refinishing equipment

- X. Rules for safe use of refinishing equipment
- A. Make sure that ventilation system supplies a constant flow of clean, fresh air
 - B. Replace paint-booth filters regularly
 - C. Display "No Smoking" signs, and make sure that they are obeyed
 - D. Always *push* vehicle out of paint booth
- (NOTE: A running engine can ignite paint vapors.)
- E. When using power refinishing equipment, follow all rules for safe use of power tools
 - F. Wear safety goggles when necessary
 - G. Wear a particle mask or respirator when necessary (Figures 81 and 82)

EXAMPLES:

FIGURE 81: Particle mask

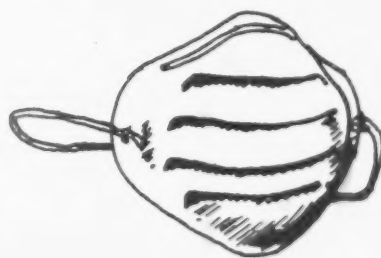


FIGURE 82: Charcoal paint respirator



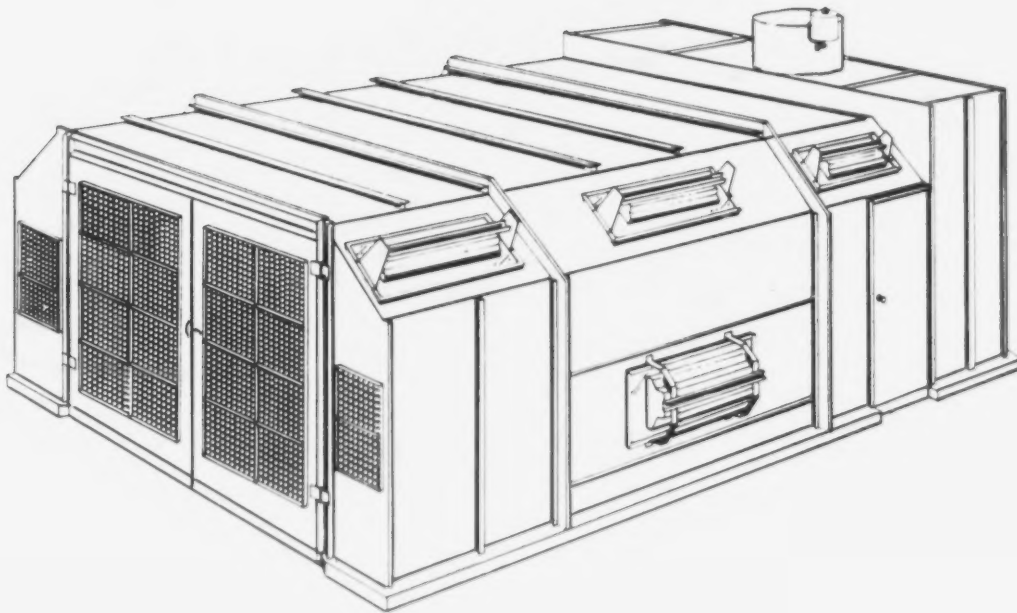
XI. Uses of refinishing equipment

- A. Paint booth — Used to isolate vehicle in order to obtain a dust-free finish, and to keep vapors and fumes from rest of shop (See Figure 83)

EXAMPLE:

INFORMATION SHEET

FIGURE 83



B. Spray guns and accessories — Used to atomize paint and apply finish (Figures 84-88)

EXAMPLES:

FIGURE 84: Paint gun

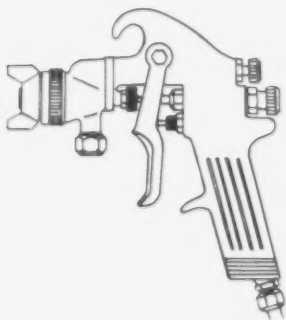
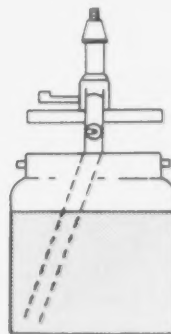


FIGURE 85: Paint cup and siphon tube



INFORMATION SHEET

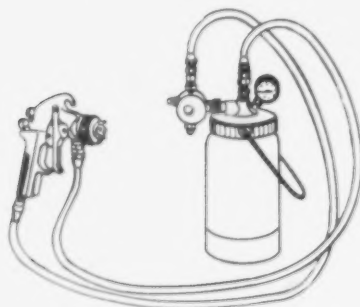
FIGURE 86: Blow gun



FIGURE 87: Air brush



FIGURE 88: Pressure pot



C. Air-supply equipment — Used to supply shop and spray equipment with clean, dry air (Figures 89 and 90)

EXAMPLES:

FIGURE 89: Air compressor

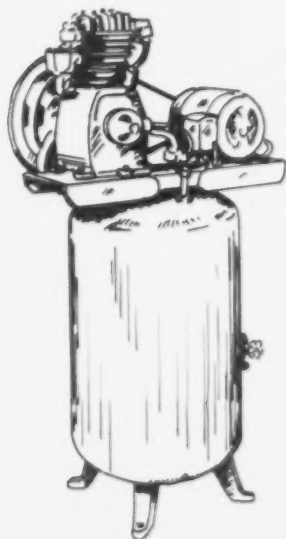
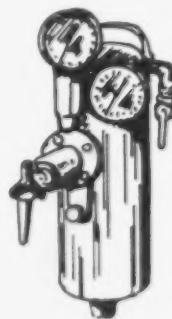


FIGURE 90: Air regulator with water trap



INFORMATION SHEET

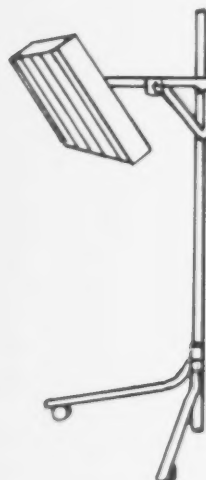
- D. Drying equipment — Used to force heat and hot, dry air over finish (Figures 93 and 94)

EXAMPLES:

FIGURE 91: Panel drying system



FIGURE 92: Spot-repair drying system

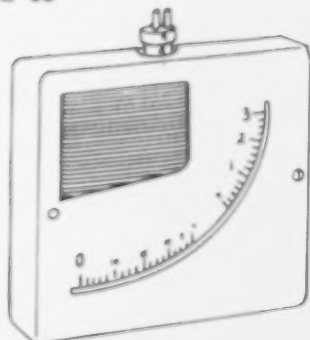


- E. Miscellaneous refinishing equipment

1. Draft gauge — Used to measure flow of air in paint booth (Figure 93)

EXAMPLE:

FIGURE 93



INFORMATION SHEET

2. Viscosity cup — Used to test paint's consistency (Figure 94)

EXAMPLE:

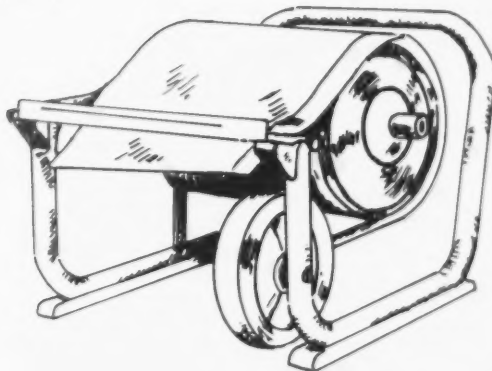
FIGURE 94



3. Apron taper — Used to store and dispense masking paper and masking tape (Figure 95)

EXAMPLE:

FIGURE 95



4. Sanding block — Used with sandpaper to finish sand before application of top coat (Figure 96)

INFORMATION SHEET

EXAMPLE:

FIGURE 96



BODY AND REFINISHING EQUIPMENT
UNIT VIII

ASSIGNMENT SHEET #1 — COMPLETE SAFETY TEST
FOR BODY AND REFINISHING EQUIPMENT

NAME _____ SCORE _____

To use tools correctly, you must know not only the operating instructions but also the safety rules for the tools. Complete each of the following safety rules for body and refinishing equipment. Write the correct answers in the blanks.

PART I: Rules for care and safe use of hand tools used for body work

- A. Use the _____ for the job
- B. Keep tools _____
- C. _____ tools frequently to make sure that they are in good condition
- D. _____ of broken or damaged tools that cannot be repaired
- E. _____ tools _____ when not in use
- F. _____ when using tools
- G. Wear appropriate _____ when necessary

PART II: Rules for safe use of power tools used for body work

- A. Do not attempt to operate any power tool before being _____
_____ by the instructor on that particular tool
- B. Always wear eye protection when _____ a power tool
- C. Wear appropriate _____ for job being done
- D. Do not _____ others or let anyone _____ you while operating a power tool
- E. Do not leave power tool _____ unattended
- F. Assume a safe and comfortable _____ before using a power tool
- G. Be sure that electrical power tool is properly _____ before using

ASSIGNMENT SHEET #1

- H. Be sure that power tool is _____ before performing maintenance or changing accessories
- I. Do not use _____ or _____ tool or accessories
- J. Use a power tool only for its _____
- K. Keep _____, _____, and _____ away from blade and other moving parts of a power tool
- L. Do not use a power tool with _____ or _____ removed
- M. Do not operate a power tool if _____ or _____ are wet
- N. Keep _____ clean at all times
- O. Before attempting to use it, be familiar with the _____ and _____ of power tool
- P. Keep a _____ on the power tool at all times
- Q. Use _____ and _____ of sufficient size to service particular power tool you are using

PART III: Guidelines for proper care of power tools used for body work

- A. Keep tools _____ and in good _____
- B. Keep machine surfaces _____ and in good _____
- C. Follow manufacturer's _____
- D. Protect _____
- E. Keep all tool _____ sharp
- F. Report any unusual _____, _____, or _____ to the instructor

ASSIGNMENT SHEET #1

- G. Inspect tools and accessories _____
- H. Store tools in their _____ when not in use

PART IV: Rules for safe use of refinishing equipment

- A. Make sure that _____ supplies a constant flow of clean, fresh air
- B. Replace _____ regularly
- C. Display _____, and make sure that they are obeyed
- D. Always _____ vehicle out of paint booth
- E. When using power refinishing equipment, follow all _____ for _____ of power tools
- F. Wear safety _____ when necessary
- G. Wear a _____ or _____ when necessary

BODY AND REFINISHING EQUIPMENT
UNIT VIII

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

PART I

- A. Correct tool
- B. Clean
- C. Inspect
- D. Dispose
- E. Store, properly
- F. Stay alert
- G. Eye protection

PART II

- A. Checked out
- B. Operating
- C. Clothing
- D. Distract, distract
- E. Running
- F. Position
- G. Grounded
- H. Disconnected
- I. Dull, broken
- J. Intended use
- K. Feet, fingers, hair
- L. Guards, safety devices
- M. Hands, feet
- N. Work areas
- O. Correct operation, adjustments
- P. Firm grip
- Q. Electric extension cords, air hoses

PART III

- A. Clean, working order
- B. Clean, working order
- C. Maintenance procedures
- D. Cutting edges
- E. Accessories
- F. Noises, sounds, vibrations
- G. Regularly
- H. Proper place

PART IV

- A. Ventilation system
- B. Paint-booth filters
- C. "No Smoking" signs
- D. Push
- E. Rules, safe use
- F. Goggles
- G. Particle mask, respirator

BODY AND REFINISHING EQUIPMENT
UNIT VIII

JOB SHEET #1 — USE A BENCH GRINDER
TO DRESS A COLD CHISEL

I. Equipment and materials

- A. Bench grinder
- B. Wheel dressing tool
- C. Goggles or full-face shield
- D. Cold chisel
- E. Pan of water

II. Procedure

- A. Put on goggles or face shield
- B. Dress grinding wheel if needed

(NOTE: Check with the instructor to learn this procedure.)

- C. Adjust tool rest to proper clearance

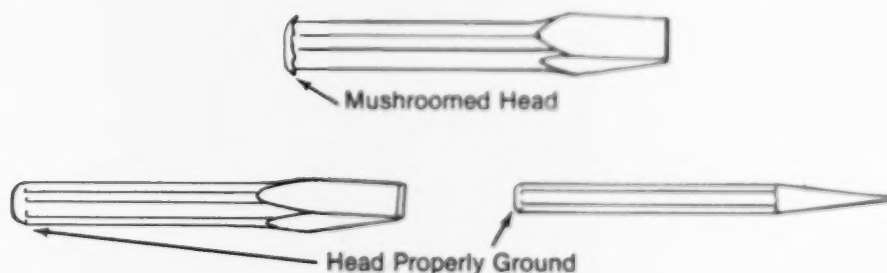
(NOTE: Proper clearance is approximately $\frac{1}{16}$ to $\frac{1}{8}$ inch from grinding wheel.)

- D. Rotate grinding wheel by hand to make sure that it will clear tool rest
- E. Turn on grinder
- F. Grind head of chisel, dipping head in water occasionally to keep it from getting too hot

CAUTION

When the head of the chisel is mushroomed (see Figure 97), chips may fly off during grinding.

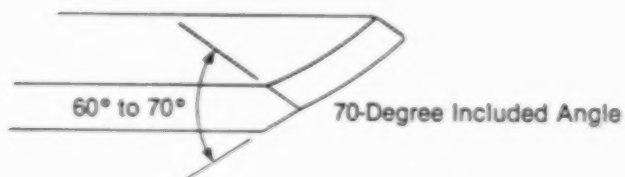
FIGURE 97



JOB SHEET #1

- G. Grind cutting edge of chisel, dipping tip in water occasionally to keep it from getting too hot
1. Rest chisel on tool rest and apply slight pressure to grinding wheel
 2. Grind cutting edge of chisel symmetrically to an included angle of 60 to 70 degrees, with a slightly convex edge (Figure 98)

FIGURE 98



- H. Clean work area and return equipment and materials to proper storage

BODY AND REFINISHING EQUIPMENT
UNIT VIII

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with body and refinishing equipment. Write the correct numbers in the blanks.

- | | |
|--|---------------------|
| _____ a. Tapering rough edges of paint or body filler | 1. Roughing out |
| _____ b. Leveling and smoothing sheet metal that has already been roughed out, restoring it as close to its original shape as possible | 2. Bumping |
| _____ c. Straightening ridges and other high surfaces in sheet metal | 3. Shrinking |
| _____ d. To break liquid into tiny droplets | 4. Spring-hammering |
| _____ e. Contracting expanded sheet metal back to its original size and shape | 5. Featheredging |
| _____ f. Straightening auto body's inner construction or reinforcement and roughly reshaping damaged outer sheet metal | 6. Atomize |
| _____ g. Body design in which body and frame are combined into one unit | 7. Unibody |

2. State four rules for care and safe use of hand tools used for body work.

- a. _____

- b. _____

- c. _____

- d. _____

TEST

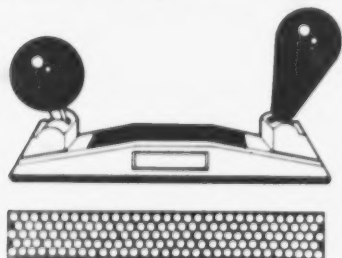
3. Match to their correct descriptions hand tools used for body straightening. Write the correct numbers in the blanks.

- | | |
|---|----------------------|
| _____a. Metal hammer with a smooth, round face and a sharp end; smooth face is used alone for working down high spots and with a dolly for working metal down; sharp end is used for picking up small dents | 1. Shrinking hammer |
| _____b. Small, variously shaped hand anvils made of high-grade steel; used as back-up tools in roughing and bumping | 2. Bumping hammer |
| _____c. Metal hammer with a round face and a square face; used for finishing and light shrinking | 3. Dinging hammer |
| _____d. Small tools that come in various shapes and sizes; used alone for prying out dents in restricted, confined areas and with a hammer for spring-hammering | 4. Pick hammer |
| _____e. Long, thin tool with a hook on one end and a handle on other end; hook is inserted into a hole in metal and used for pulling out shallow dents | 5. Cross-peen hammer |
| _____f. Combination hammer that has a flat, serrated end and a sharp end; used for shrinking and for picking up small dents | 6. Dead-blow hammer |
| _____g. All-purpose tool with curved and slotted ends; used as a lever | 7. Dollies |
| _____h. Tools with a pointed end and a turning handle; used for forcing out and bringing up small damaged or low areas | 8. Spoons |
| _____i. Metal hammer with two flat, serrated faces; used with various shapes of dollies for repairing slightly stretched metal | 9. Body file |
| _____j. Plierlike tool with serrated blades; used for cutting metal patches and for cutting out pieces of metal that cannot be repaired | 10. Pick |
| _____k. Soft hammer with metal shot inside head to prevent rebound; used for straightening metal when great striking force is needed | 11. Slide hammer |
| | 12. Pull rod |
| | 13. Pry bar |
| | 14. Metal shears |

TEST

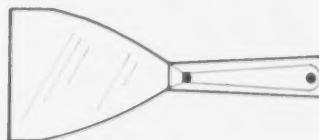
- ____ l. Holder and blade used for working down very small high places after the damaged area has been aligned and dollyed almost to original contour
- ____ m. Tool consisting of a metal shaft on which a handle and a sliding weight are mounted; used with a large sheet-metal screw for pulling out dents in metal
- ____ n. A light bumping hammer with two round faces; used alone for roughing and with a dolly for shrinking
4. Identify the following hand tools used for body filling and shaping. Write the correct names in the blanks.

Plastic-finishing board file
Mixing board and spreader

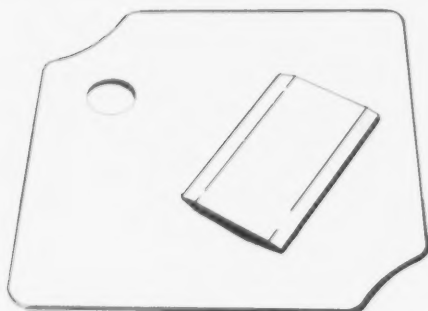


a. _____

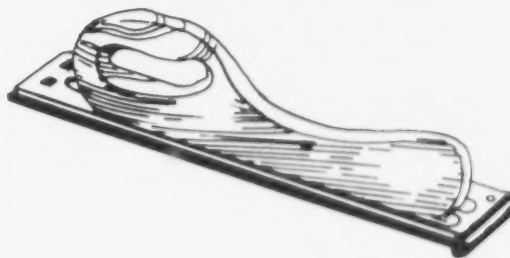
Putty knife
Plastic-shaping file



b. _____



c. _____



d. _____

TEST

5. Identify hand tools used for special body work. Write the correct names in the blanks.

Vacuum lifter

Windshield knife

Door and window handle-clip remover

Reveal-molding clip tool

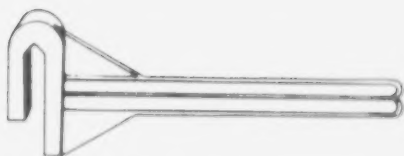
Locking-strip tool

Pop-rivet gun

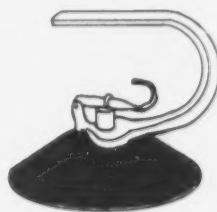
Door-hinge wrench

Bumper-bracket tool

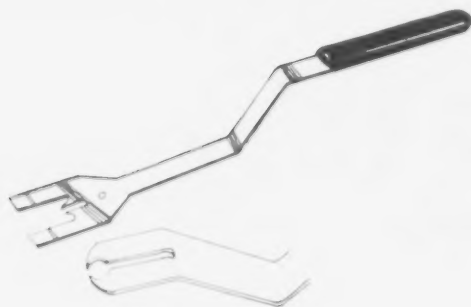
Door-hinge aligner



a. _____



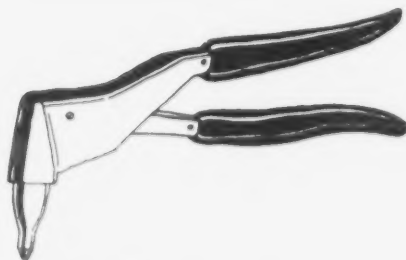
b. _____



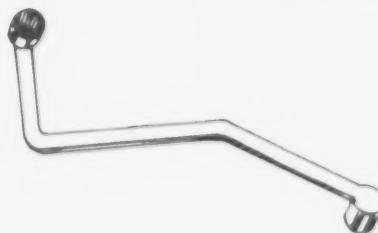
c. _____



d. _____

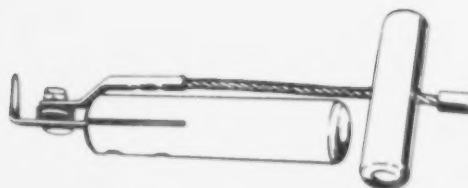
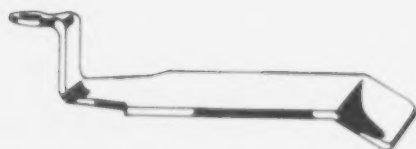


e. _____

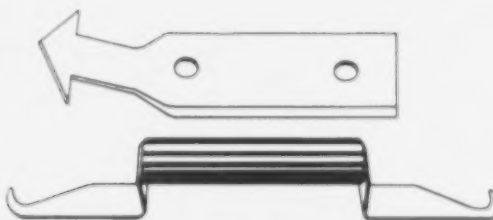


f. _____

TEST



g. _____ h. _____



i. _____

6. State eight rules for safe use of power tools used for body work.

- a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

TEST

- g. _____

 h. _____

7. State four guidelines for proper care of power tools used for body work.

- a. _____
 b. _____
 c. _____
 d. _____

8. Match to their correct uses hand-operated power tools used for body work. Write the correct numbers in the blanks.

- | | |
|--|-----------------------|
| _____ a. Used to drill and bore; used with wire-brush attachment to clean metal | 1. Grinder |
| _____ b. Used to smooth metal and to sand and feather-edge paint | 2. Polisher |
| _____ c. Used to remove paint, to buff and grind metal, and to grind welds | 3. Drill |
| _____ d. Used to loosen and tighten bolts | 4. Pneumatic hammer |
| _____ e. Used to rough out or shape body filler and to grind close areas such as on door posts or around windows | 5. Orbital sander |
| _____ f. Used to tighten and loosen nuts and bolts | 6. Oscillating sander |
| _____ g. Used to polish paint | 7. Impact wrench |
| _____ h. Used to cut spot welds, remove panels, chisel, and rivet | 8. Power metal shear |
| _____ i. Used to sand and featheredge paint and to rough-shape plastic body filler | 9. Pneumatic ratchet |
| _____ j. Used to cut sheet metal | 10. Bench grinder |
| _____ k. Used to dress punches and chisels, to sharpen drill bits, and to grind metal | 11. Roloc disc |

TEST

9. Match to their correct uses portable and stationary power equipment used for body work. Write the correct numbers in the blanks.

- | | |
|--|---|
| _____ a. Used to raise vehicle to gain access to underside | 1. Frame- and panel-straightening equipment |
| _____ b. Used to clean vehicle, engine, and underbody | 2. Body jacks and accessories |
| _____ c. Used to secure lifted vehicle so that vehicle will be safe to work under | 3. Floor jacks and lifts |
| _____ d. Used to connect frame members and rails, to connect body panels, and to spot weld | 4. Safety stand |
| _____ e. Used to drill and bore holes | 5. Vacuum cleaner |
| _____ f. Used to align body parts and to align and straighten frame and unibody | 6. Car wash and steam-cleaning system |
| _____ g. Used to align body parts, to straighten frame members, and to align unibody and unibody members | 7. Drill press |
| _____ h. Used to pick up dirt and dust; some types are used to pick up liquids | 8. Welder |

10. State three rules for safe use of refinishing equipment.

- a. _____
- b. _____
- c. _____

11. Match types of refinishing equipment to their correct uses. Write the correct numbers in the blanks. Equipment and uses are continued on the next page.

- | | |
|--|-------------------------------|
| _____ a. Used to force heat and hot, dry air over finish | 1. Paint booth |
| _____ b. Used to isolate vehicle in order to obtain a dust-free finish, and to keep vapors and fumes from rest of shop | 2. Spray guns and accessories |
| _____ c. Used to supply shop and spray equipment with clean, dry air | 3. Air-supply equipment |
| _____ d. Used to test paint's consistency | 4. Drying equipment |
| _____ e. Used with sandpaper to finish sand before application of top coat | 5. Draft gauge |

TEST

- | | |
|---|------------------|
| _____f. Used to atomize paint and apply finish | 6. Viscosity cup |
| _____g. Used to measure flow of air in paint booth | 7. Apron taper |
| _____h. Used to store and dispense masking paper and masking tape | 8. Sanding block |

(NOTE: Test questions 12 and 13 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

12. Complete safety test for body and refinishing equipment.
13. Demonstrate the ability to use a bench grinder to dress a cold chisel.

BODY AND REFINISHING EQUIPMENT
UNIT VIII

ANSWERS TO TEST

1. a. 5 e. 3
 b. 2 f. 1
 c. 4 g. 7
 d. 6

2. Answer should include any four of the following
 - a. Use the correct tool for the job
 - b. Keep tools clean
 - c. Inspect tools frequently to make sure that they are in good condition
 - d. Dispose of broken or damaged tools that cannot be repaired
 - e. Store tools properly when not in use
 - f. Stay alert when using tools
 - g. Wear appropriate eye protection when necessary

3. a. 4 h. 10
 b. 7 i. 1
 c. 2 j. 14
 d. 8 k. 6
 e. 12 l. 9
 f. 5 m. 11
 g. 13 n. 3

4. a. Plastic-shaping file c. Mixing board and spreader
 b. Putty knife d. Plastic-finishing board file

5. a. Bumper-bracket tool f. Door-hinge wrench
 b. Vacuum lifter g. Locking-strip tool
 c. Door and window handle-clip h. Windshield knife
 remover i. Reveal-molding clip tool
 d. Door-hinge aligner
 e. Pop-rivet gun

6. Answer should include any eight of the following
 - a. Do not attempt to operate any power tool before being checked out by the instructor on that particular tool
 - b. Always wear eye protection when operating a power tool
 - c. Wear appropriate clothing for job being done
 - d. Do not distract others or let anyone distract you while operating a power tool
 - e. Do not leave power tool running unattended
 - f. Assume a safe and comfortable position before using a power tool
 - g. Be sure that electrical power tool is properly grounded before using

ANSWERS TO TEST

- h. Be sure that power tool is disconnected before performing maintenance or changing accessories
 - i. Do not use dull or broken tool or accessories
 - j. Use a power tool only for its intended use
 - k. Keep feet, fingers, and hair away from blade and other moving parts of a power tool
 - l. Do not use a power tool with guards or safety devices removed
 - m. Do not operate a power tool if hands or feet are wet
 - n. Keep work area clean at all times
 - o. Before attempting to use it, be familiar with the correct operation and adjustments of power tools
 - p. Keep a firm grip on the power tool at all times
 - q. Use electric extension cords of sufficient size to service particular power tool you are using
7. Answer should include any four of the following
- a. Keep tools clean and in good working order
 - b. Keep machine surfaces clean and in good working order
 - c. Follow manufacturer's maintenance procedures
 - d. Protect cutting edges
 - e. Keep all tool accessories, such as blades and bits, sharp
 - f. Report any unusual noises, sounds, or vibrations to the instructor
 - g. Inspect tools and accessories regularly
 - h. Store tools in their proper place when not in use
- 8.
- | | |
|-------|-------|
| a. 3 | g. 2 |
| b. 5 | h. 4 |
| c. 1 | i. 6 |
| d. 7 | j. 8 |
| e. 11 | k. 10 |
| f. 9 | |
- 9.
- | | |
|------|------|
| a. 3 | e. 7 |
| b. 6 | f. 1 |
| c. 4 | g. 2 |
| d. 8 | h. 5 |
10. Answer should include any three of the following
- a. Make sure that ventilation system supplies a constant flow of clean, fresh air
 - b. Replace paint-booth filters regularly
 - c. Display "No Smoking" signs, and make sure that they are obeyed
 - d. Always *push* vehicle out of paint booth
 - e. When using power refinishing equipment, follow all rules for safe use of power tools
 - f. Wear safety goggles when necessary
 - g. Wear a particle mask or respirator when necessary

ANSWERS TO TEST

11. a. 4 e. 8
 b. 1 f. 2
 c. 3 g. 5
 d. 6 h. 7
12. Evaluated to the satisfaction of the instructor
13. Performance skills evaluated to the satisfaction of the instructor

FASTENERS UNIT IX

UNIT OBJECTIVE

After completing this unit, the student should be able to identify, remove, and replace various fasteners common to the automotive industry. The student will show this knowledge by completing the assignment sheet, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with fasteners to their correct definitions.
2. Identify types of bolts used in body and chassis construction and repair.
3. Match customary and metric bolts to their correct grading systems and markings.
4. Identify types of nuts commonly used in body and chassis construction and repair.
5. Identify types of washers commonly used in body and chassis construction and repair.
6. Identify types of screws commonly used in body and chassis construction and repair.
7. List methods of removing nuts and bolts that are seized due to rust or corrosion.
8. Identify types of rivets commonly used in body and chassis construction and repair.
9. List methods of attaching exterior molding and trim.
10. Identify common types of exterior molding and trim fasteners.
11. Determine bolt and wrench sizes.
12. Demonstrate the ability to
 - a. Fasten two pieces of metal with hollow (pop) rivets.
 - b. Remove and replace a belt molding.
 - c. Remove and replace a rocker-panel molding.
 - d. Remove and replace a wheel-opening molding.
 - e. Remove and replace a windshield metal reveal molding.
 - f. Remove and replace a drip-rail scalp molding.
 - g. Remove and replace an emblem or nameplate.
 - h. Remove and replace adhesive-bonded side molding.

FASTENERS
UNIT IX

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Information sheet
 - D. Assignment Sheet #1 — Determine Bolt and Wrench Sizes
 - E. Answers to assignment sheet
 - F. Job sheets
 - 1. Job Sheet #1 — Fasten Two Pieces of Metal with Hollow (Pop) Rivets
 - 2. Job Sheet #2 — Remove and Replace a Belt Molding
 - 3. Job Sheet #3 — Remove and Replace a Rocker-Panel Molding
 - 4. Job Sheet #4 — Remove and Replace a Wheel-Opening Molding
 - 5. Job Sheet #5 — Remove and Replace a Windshield Metal Reveal Molding
 - 6. Job Sheet #6 — Remove and Replace a Drip-Rail Scalp Molding
 - 7. Job Sheet #7 — Remove and Replace an Emblem or Nameplate
 - 8. Job Sheet #8 — Remove and Replace Adhesive-Bonded Side Molding
 - G. Test
 - H. Answers to test
- II. Instructor's guide
 - A. Review unit and plan presentation.
 - B. Order or obtain materials to supplement unit.
 - 1. Tools and equipment necessary for demonstration and completion of job sheets
 - 2. Variety of fasteners for class discussion and display
 - 3. Fastener catalogs from local supplier

SUGGESTED ACTIVITIES

4. Variety of penetrating oils
5. Variety of bolts of different sizes and lengths

(NOTE: Obtain enough bolts so that each class member may have four bolts of different sizes and lengths for Assignment Sheet #1.)

6. Nut splitter, cold chisel, hammer, hacksaw and blades, oxyacetylene torch for demonstrating removal of seized nuts and bolts
7. Seized nuts and bolts from local salvage yard
8. Small steel scales or accurate rules and thread gauges for each student
9. Competency profiles

(NOTE: Competency profiles are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Explain the importance of fasteners in the auto-body industry.
- Point out that many different types of fasteners are necessary for assembling a single panel, such as a door.

E. Discuss unit and specific objectives.

F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to introduce students to terminology associated with fasteners.
2. Use Information Sheet, Section II to discuss the types of bolts used in automobile body and chassis construction.

SUGGESTION:

- Show the class samples of different types and sizes of bolts.
3. Use Information Sheet, Section III to discuss the grading systems and markings on customary and metric bolts.

SUGGESTIONS:

- Show the class samples of customary and metric bolts with grade or strength markings.

SUGGESTED ACTIVITIES

- Explain why stronger bolts are needed in some situations, and give examples of places in which different bolt strengths are used on the automobile.
 - Invite a local supplier or an industry person knowledgeable in this area to speak to the class.
4. Use Information Sheet, Section IV to discuss the types of nuts commonly used in body and chassis construction and repair.

SUGGESTIONS:

- Show the class samples of various types of nuts, and explain where each type of nut might be used.
 - Explain the importance of matching the threads of the nut to the bolt being used.
 - Explain how mismatched threads can allow assemblies or parts to work loose during operation, which could cause damaged parts or cause an accident.
5. Use Information Sheet, Section V to discuss the types and styles of washers used in body and chassis construction and repair.

SUGGESTIONS:

- Show the class samples of various types and styles of washers.
 - Discuss the purpose of each type of washer.
 - Give examples of places in which each type of washer might be found on the automobile.
 - Explain that when making repairs, the technician must take care to return washers to their proper places during reassembly.
6. Use Information Sheet, Section VI to discuss the types of screws commonly used in the automotive industry.

SUGGESTIONS:

- Show the class samples of the various types of screws they may encounter during body or chassis repair.
- Explain where in the automobile assembly they might find each type of screw.

SUGGESTED ACTIVITIES

7. Use Information Sheet, Section VII to discuss methods used to remove seized nuts and bolts.

SUGGESTIONS:

- Show the class samples of seized nuts and bolts.
- Explain where in the automobile they might encounter seized nuts and bolts.

EXAMPLES: Shock-absorber nuts, exhaust-system bolts, fender-attaching bolts, bumper-bracket bolts

- Show the class samples of penetrating oil. Discuss its proper use and the expected results.
 - Show the class a nut splitter and explain its use.
 - Stress safety precautions when using the nut splitter.
 - Show the class a cold chisel and the proper hammer to use for removing a seized nut. Explain how to determine the proper type and size of chisel.
 - Demonstrate how to remove a seized nut with a cold chisel and hammer.
 - Discuss the type of hacksaw blade best suited for nut removal.
 - Demonstrate how to use a hacksaw to remove a seized nut.
 - Demonstrate how to use an oxyacetylene torch to remove a seized nut.
 - Stress safety rules to follow when using a torch for nut removal.
 - Discuss with the class how to determine which removal method to use.
8. Use Information Sheet, Section VIII and Job Sheet #1 to discuss common types of rivets used in body and chassis construction and repair.

SUGGESTIONS:

- Show the class samples of the various types of rivets they might encounter during repairs.
- Explain the purpose of each type of rivet.
- Give examples of places in which each type of rivet is used on the automobile.

EXAMPLES: Grille, exterior trim

SUGGESTED ACTIVITIES

- Demonstrate the procedure outlined in Job Sheet #1.
 - Have students complete Job Sheet #1.
9. Use Information Sheet, Sections IX and X and Job Sheets #2 through #8 to discuss common types of exterior molding and trim fasteners and methods of attaching exterior molding and trim.

SUGGESTIONS:

- Show the class samples of the various types of molding and trim fasteners.
 - Show samples of fasteners made from different types of materials, such as plastic, metal, and adhesive.
 - Point out the locations of various types of exterior molding fasteners on an actual vehicle.
 - Discuss the importance of salvaging good molding and trim fasteners for future use.
 - Demonstrate Job Sheets #2 through #8.
 - Have students complete Job Sheets #2 through #8.
10. Use Information Sheet, Section XI to discuss how to measure bolts to determine the correct size, length, pitch, and wrench size required.

SUGGESTIONS:

- Show the class samples of different lengths and sizes of bolts.
 - Show the class both metric and customary bolt samples.
 - Show bolts with coarse, fine, and extra-fine pitch.
 - Demonstrate how to measure to determine correct size, length, pitch, and required wrench size.
 - Have students practice measuring bolts by completing Assignment Sheet #1. Critique assignment sheet and discuss in class.
- G. Give test.
- H. Critique test and discuss in class.
- I. Reteach and retest as necessary.
- J. Complete appropriate section of competency profiles.

SUGGESTED ACTIVITIES

III. Unit references

- A. Crouse, William H., and Donald L. Anglin. *Automotive Body Repair and Refinishing*. New York: McGraw-Hill Inc., 1980.
- B. Hobson, W.T. *Automotive Refinishing Principles and Techniques*. 1st ed. Wilmington, Delaware: E.T. DuPont de Nemours and Co., 1969.
- C. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Co. of Canada Ltd., 1969.
- D. MacPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill Inc., 1971.
- E. *1980 Fisher Body Service Manual*. Warren, Michigan: General Motors Corporation, 1979.
- F. *1980 Service Manual: Plymouth Horizon, Dodge Omni*. Detroit, Michigan: Chrysler Corporation, 1979.
- G. Spicer, Edward D. *Automotive Collision Work*, 4th ed. Chicago, Illinois: American Technical Society, 1972.
- H. Toboldt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

FASTENERS
UNIT IX

INFORMATION SHEET

I. Terms and definitions

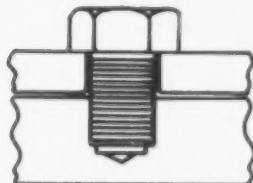
- A. Coarse thread — Unified National Coarse (UNC) or United States Standard (USS) threads used on bolts and nuts designed to hold soft or crumbly metals in place
- B. Fine thread — United National Fine (UNF) or Society of Automotive Engineers (SAE) threads used on bolts and nuts designed for great strength and accuracy
- C. Self-tapping thread — Bolt or screw designed to cut its own threads in a drilled hole
- D. Grade — Hardness of bolts; indicated by strength markings on heads of customary bolts and numbers on heads of metric bolts
- E. Self-locking nut — Nut designed to lock itself to a bolt to prevent loosening due to vibration

II. Types of bolts used in body and chassis construction (Figures 1-5)

A. Cap screw

(NOTE: Cap screws are used to hold two pieces of metal together when one piece of the metal has a threaded hole. Therefore, a nut is not required. Cap screws are available with coarse or fine threads and come in various sizes, lengths, and thread types.)

FIGURE 1

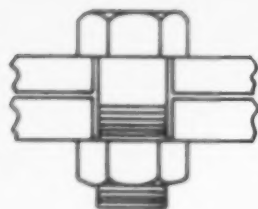


B. Hex-head bolt and nut

(NOTE: Hex-head bolts and nuts are available in either metric or customary measurements, with coarse or fine threads, and in many sizes, lengths, and thread types.)

INFORMATION SHEET

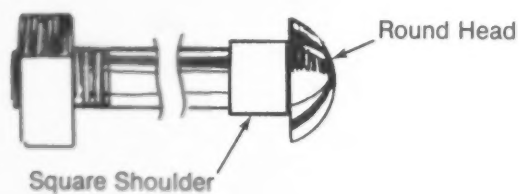
FIGURE 2



C. Carriage bolt and nut

(NOTE: A carriage bolt fits into a square hole, which prevents the bolt from turning as the nut is tightened or loosened.)

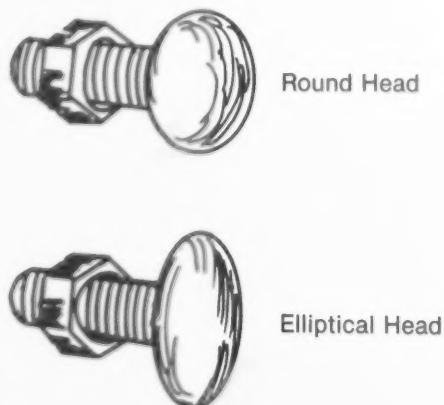
FIGURE 3



D. Bumper bolt

(NOTE: Bumper bolts are designed with either elliptical or round heads and are available with a chrome or painted head.)

FIGURE 4

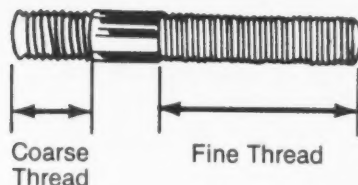


INFORMATION SHEET

E. Stud

(NOTE: Studs are fasteners threaded on both ends.)

FIGURE 5



III. Customary and metric bolt grading systems and markings

(NOTE: The grade or strength of both customary and metric bolts can be identified by markings located on the heads of the bolts. Some vehicles are assembled with both customary and metric bolts. When repairing such vehicles, take care not to interchange the fasteners. Metric and customary threads will not match and damaged parts could result.)

A. Customary system (Figures 6 - 9)

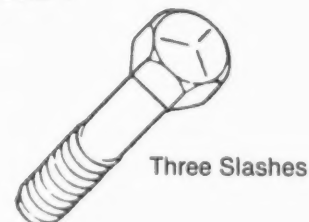
1. Grades 1 and 2

FIGURE 6



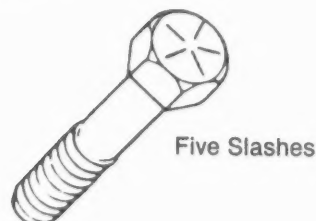
2. Grade 5

FIGURE 7



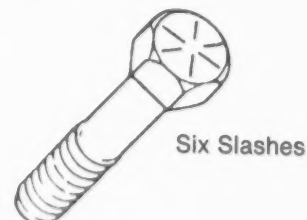
3. Grade 7

FIGURE 8



4. Grade 8

FIGURE 9

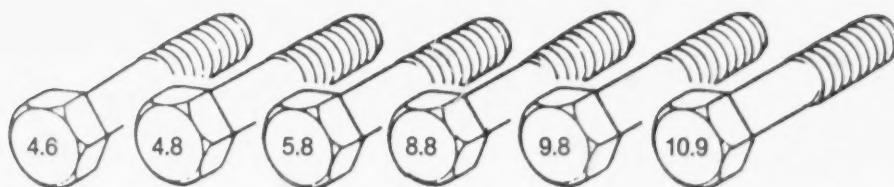


INFORMATION SHEET

B. Metric system (Figure 10)

(NOTE: The metric system uses numbers for grade identification. The larger the number, the greater the tensile strength of the bolt.)

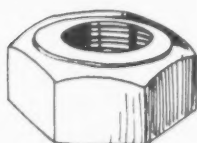
FIGURE 10



IV. Types of nuts commonly used in body and frame construction (Figures 11 - 20)

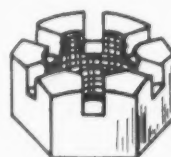
A. Hex nut

FIGURE 11



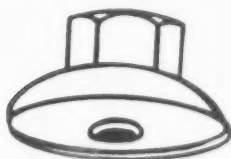
B. Slotted hex nut

FIGURE 12



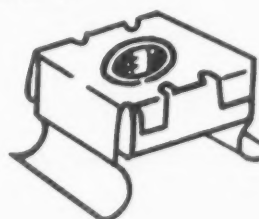
C. Flanged hex nut

FIGURE 13



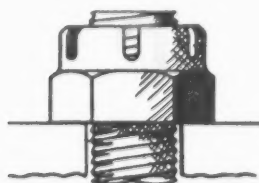
D. Retainer nut

FIGURE 14



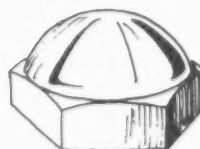
E. Castle (castellated) nut

FIGURE 15



F. Acorn nut

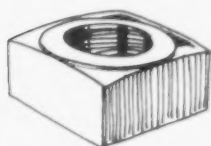
FIGURE 16



INFORMATION SHEET

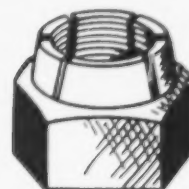
G. Square nut

FIGURE 17



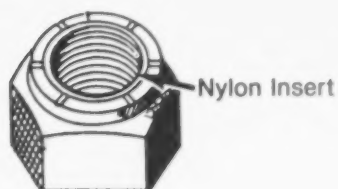
H. Prevailing torque locknut

FIGURE 18



I. Plastic insert locknut

FIGURE 19



J. Flanged locknut

FIGURE 20

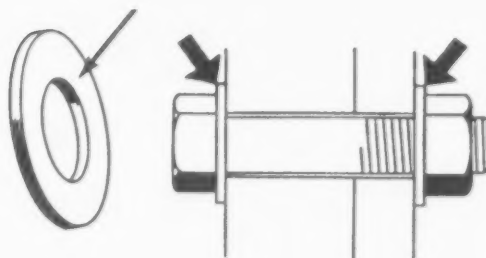


V. Washers commonly used in body and chassis construction (Figures 21 - 27)

(NOTE: Washers of all types are sized according to bolt sizes; therefore, a 1/2-inch bolt would require a 1/2-inch washer.)

A. Flat washer

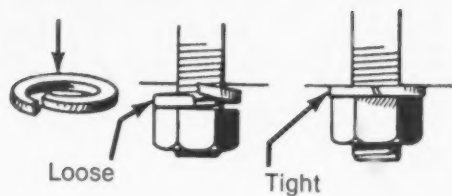
FIGURE 21



INFORMATION SHEET

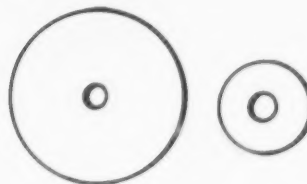
B. Spring lock washer

FIGURE 22



C. Fender washer

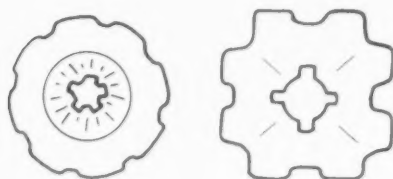
FIGURE 23



D. Body washers

(NOTE: Body washers are designed to be used with a small-diameter hole. This design allows alignment of bolt-on body panels with adjacent panels.)

FIGURE 24



E. Internal-toothed lock washer

FIGURE 25



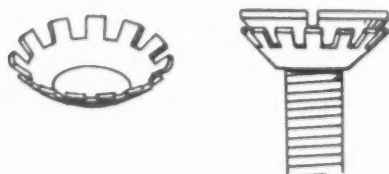
F. External-toothed lock washer

FIGURE 26



G. Countersink, external-toothed lock washer

FIGURE 27



INFORMATION SHEET

VI. Types of screws commonly used in the automotive industry

A. Machine screws (Figures 28 - 35)

(NOTE: Machine screws of all head designs, with exception of hex-head, can be purchased in either Phillips or straight-slot design. Some hexagon-head screws also have a slot so that they can be turned with a wrench or a straight-slot screwdriver.)

1. Oval

FIGURE 28



2. Round

FIGURE 29



3. Flat

FIGURE 30



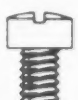
4. Binding

FIGURE 31



5. Fillister

FIGURE 32



6. Truss

FIGURE 33



7. Hexagon

FIGURE 34



8. Hexagon slot

FIGURE 35



B. Sheet-metal screws (Figures 36 - 41)

1. Round

FIGURE 36



2. Flat

FIGURE 37



3. Oval

FIGURE 38



INFORMATION SHEET

4. Pan

FIGURE 39



5. Truss

FIGURE 40



6. Hexagon slot

FIGURE 41



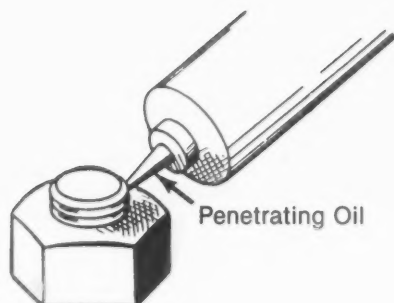
VII. Methods used to remove nuts and bolts that are seized due to rust or corrosion (Figures 42 - 46)

- A. Applying penetrating oil around bolt threads where they protrude through nut, and then removing nut with a wrench

(NOTE: Penetrating oil is most effective if the bolt with the seized nut is in the vertical position, thus allowing the solvent to penetrate all the seized threads.)

EXAMPLE:

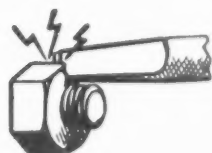
FIGURE 42



- B. Splitting nut with a cold chisel and hammer in situations where access space is limited or rust or corrosion is too severe for penetrating oil to be effective

EXAMPLE:

FIGURE 43

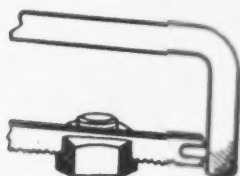


INFORMATION SHEET

- C. Sawing nut away from bolt with a hacksaw when adequate space is available

EXAMPLE:

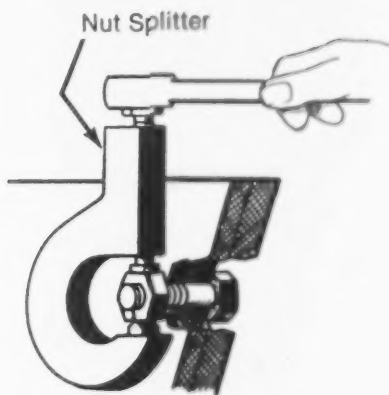
FIGURE 44



- D. Cracking nut with a nut splitter—a tool specially designed to remove seized nuts

EXAMPLE:

FIGURE 45



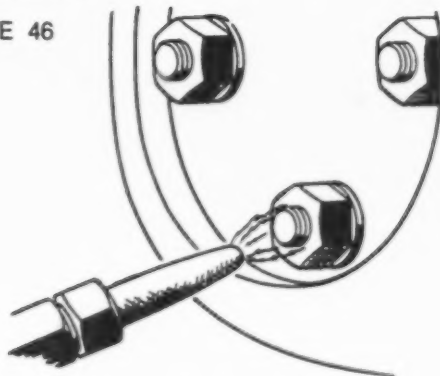
- E. Using an oxyacetylene torch to expand nut by heating it red hot and then removing it with a wrench, or using cutting torch attachment to cut off bolt or nut

(NOTE: Before using a torch to loosen seized nuts and bolts, make sure that no gas lines, brake lines, electrical wiring, or other items are present. Such items can be damaged or cause injury to the technician.)

INFORMATION SHEET

EXAMPLE:

FIGURE 46

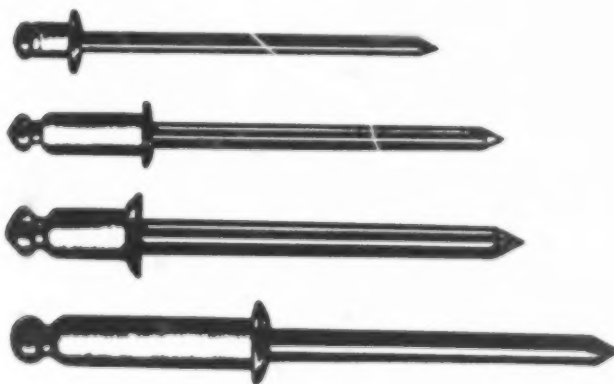


VIII. Types of rivets commonly used in body and chassis construction and repair (Figures 47 - 53)

(NOTE: Rivets are used to join two pieces of material and are available in several different sizes to accommodate different material thicknesses.)

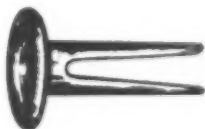
A. Hollow (pop) rivets

FIGURE 47



B. Split rivet

FIGURE 48



C. General-purpose rivet (oval)

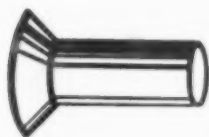
FIGURE 49



INFORMATION SHEET

D. Countersink rivet

FIGURE 50



E. Hollow rivet

FIGURE 51



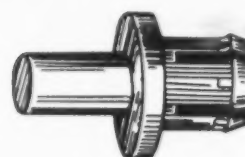
F. Shoulder rivet

FIGURE 52



G. Plastic self-locking rivet

FIGURE 53

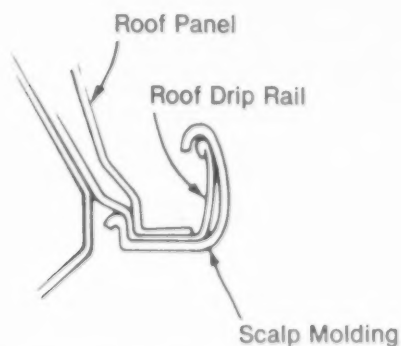


IX. Methods of attaching exterior molding and trim

- A. Adhesive
- B. Integral studs and nuts
- C. Screws
- D. Clips
- E. Screws and clips
- F. Snap-over components (Figure 54)

EXAMPLE: Snap-over, drip-rail scalp molding

FIGURE 54



Used with permission of Fisher Body Division, General Motors Corporation.

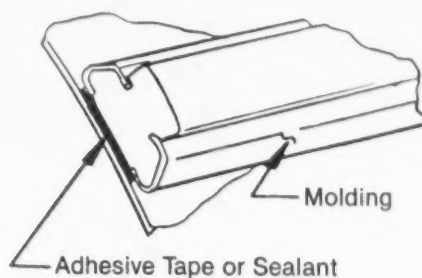
INFORMATION SHEET

X. Common types of exterior molding and trim fasteners

A. Tape or sealant (Figure 55)

(NOTE: Body side moldings on some automobiles are attached with a special adhesive tape or with sealant.)

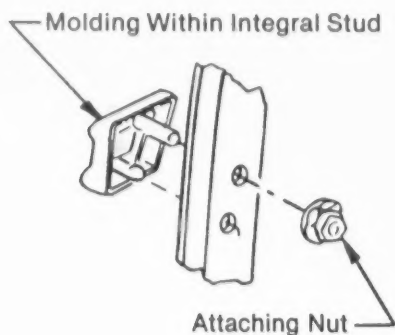
FIGURE 55



Used with permission of Fisher Body Division, General Motors Corporation.

B. Integral stud and nut (Figure 56)

FIGURE 56



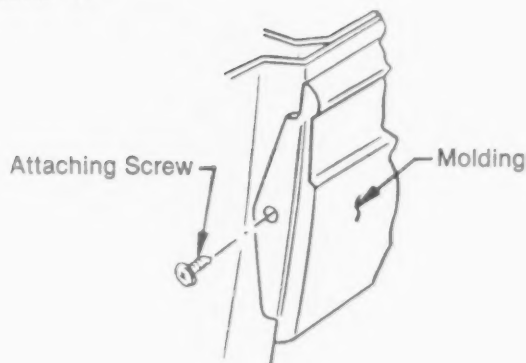
Used with permission of Fisher Body Division, General Motors Corporation.

C. Screw (See Figure 57)

(NOTE: Some moldings—such as wheel-opening moldings—are mounted to the body by sheet-metal screws only. Other moldings—such as rocker-panel moldings—are held only at the ends by sheet-metal screws.)

INFORMATION SHEET

FIGURE 57



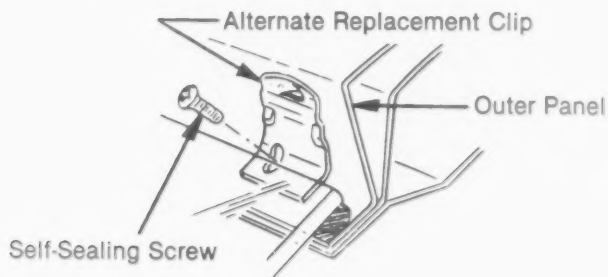
Used with permission of Fisher Body Division, General Motors Corporation.

D. Screw and clip (Figures 58 and 59)

1. Screw-attached reveal molding clip

(NOTE: The screw-attached reveal molding clip is an alternate replacement clip used when weld studs are damaged or broken off. The attaching screw is self-sealing to prevent leaks.)

FIGURE 58



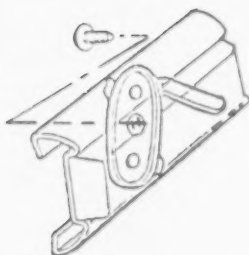
Used with permission of Fisher Body Division, General Motors Corporation.

2. Attaching screw and clip

(NOTE: This type of clip requires access to the back of the panel, and often requires removing an inside trim panel.)

INFORMATION SHEET

FIGURE 59



Attaching Screw and Clip

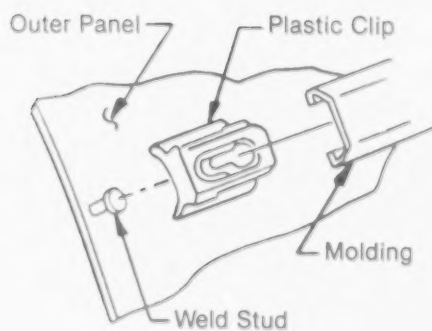
Used with permission of Fisher Body Division, General Motors Corporation.

E. Clip (Figures 60 - 69)

1. Weld-stud clip

(NOTE: Some weld-stud clips are made of plastic. Extreme care should be used when removing moldings attached with plastic weld-stud clips to prevent damage to clips.)

FIGURE 60

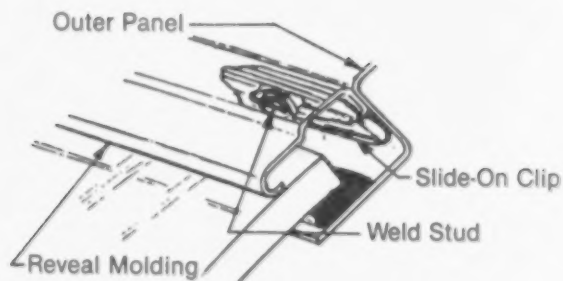


Used with permission of Fisher Body Division, General Motors Corporation.

INFORMATION SHEET

2. Slide-on clip

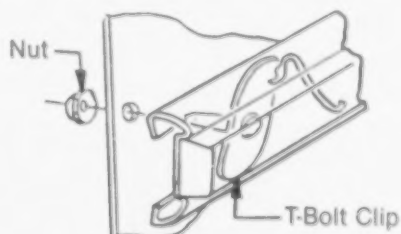
FIGURE 61



Used with permission of Fisher Body Division, General Motors Corporation.

3. T-bolt or spring-bolt clip

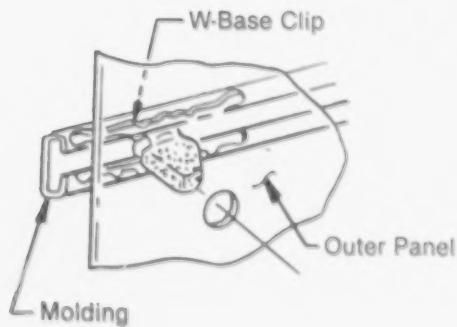
FIGURE 62



Used with permission of Fisher Body Division, General Motors Corporation.

4. W-base clip

FIGURE 63



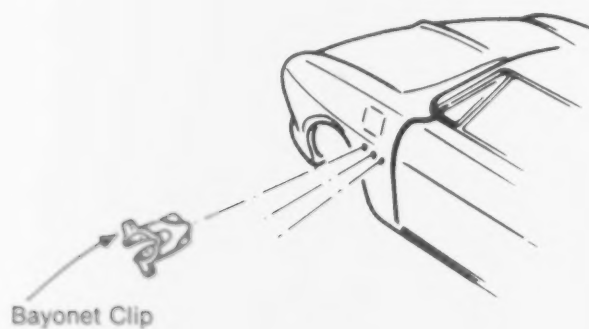
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INFORMATION SHEET

5. Bayonet clip

(NOTE: Bayonet clips are used for attaching script nameplates. The nameplate is installed by pressing the clips into drilled holes, and then pressing the integral studs on the nameplate [Figure 65] into the bayonet clips.)

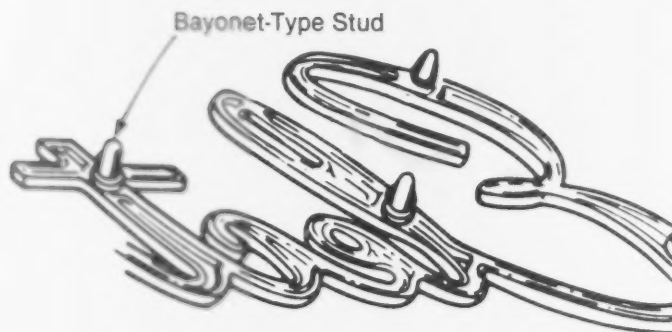
FIGURE 64



Used with permission of Fisher Body Division, General Motors Corporation.

EXAMPLE:

FIGURE 65

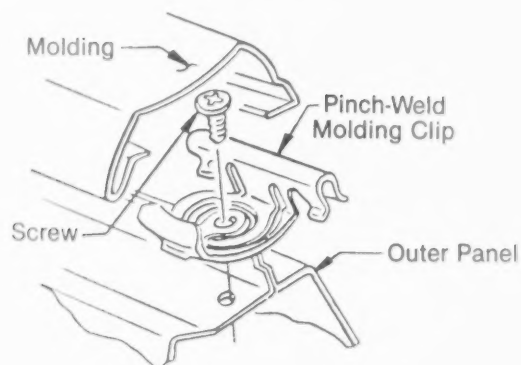


Used with permission of Fisher Body Division, General Motors Corporation.

INFORMATION SHEET

6. Pinch-weld clip

FIGURE 66

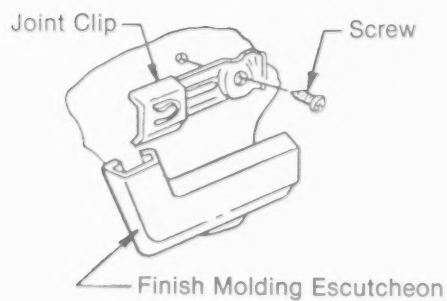


Used with permission of Fisher Body Division, General Motors Corporation.

7. Joint clip

(NOTE: Joint clips are used to join two moldings, such as window reveal moldings.)

FIGURE 67

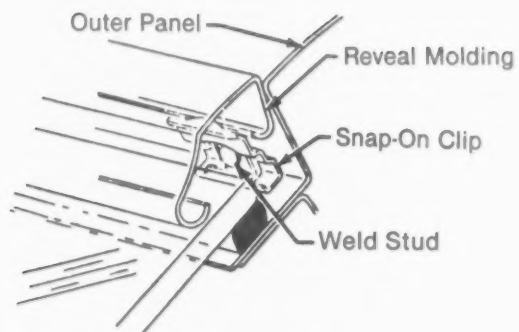


Used with permission of Fisher Body Division, General Motors Corporation.

INFORMATION SHEET

8. Snap-on clip

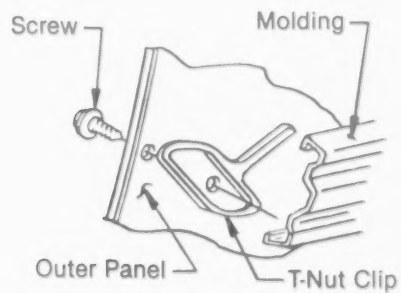
FIGURE 68



Used with permission of Fisher Body Division, General Motors Corporation.

9. T-nut clip

FIGURE 69



Used with permission of Fisher Body Division, General Motors Corporation.

FASTENERS UNIT IX

ASSIGNMENT SHEET #1 — DETERMINE BOLT AND WRENCH SIZES

NAME _____

SCORE _____

Auto-body repairs often involve disassembly and reassembly of steering, suspension, and other critical components of the automobile. The same bolt or an exact replacement should always be used when making body or mechanical repairs. Therefore, technicians making such repairs should be able to accurately determine bolt size, bolt length, threads per inch, and the required wrench size to properly fit the bolt.

Ask your instructor to provide you with four bolts of various sizes and lengths. Using a small steel scale and an accurate rule or thread gauge, solve the following problems by measuring the four bolts and recording the measurements in the appropriate blanks. Refer to the following steps as necessary.

Part I—Steps for determining bolt sizes

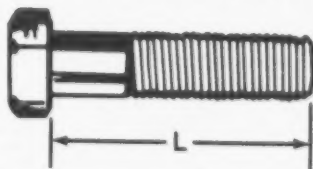
A. Bolt size

(NOTE: Bolt size and wrench size are not the same.)

1. Determine bolt diameter by measuring diameter of thread end



2. Determine bolt length by measuring distance from bottom of head to end of threads



(NOTE: Some carriage bolts with round, flat, tapered heads are measured from the top of the head to the end of the threads. See examples below.)

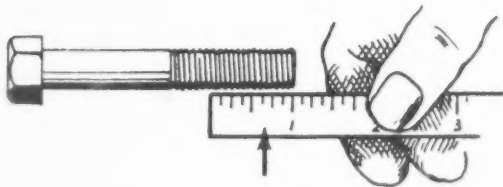


ASSIGNMENT SHEET #1

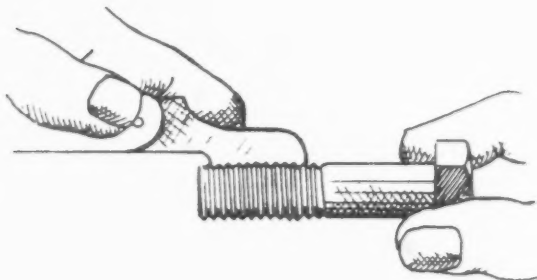
3. Determine threads per inch (pitch) by measuring with a thread gauge or rule and counting the number of threads contained in 1 inch.

(NOTE: Bolts are available in three different thread series: coarse, fine, and extra-fine. Coarse threads equal thirteen threads per inch; fine threads equal twenty threads per inch; and extra-fine threads equal twenty-eight threads per inch.)

Measuring with a rule



Measuring with a thread gauge



- B. Wrench size — Determine by measuring width of bolt head with a rule



ASSIGNMENT SHEET #1

Part II—Determine bolt sizes

A. Bolt #1

- _____ 1. Bolt size
- _____ 2. Threads per inch
- _____ 3. Bolt length
- _____ 4. Wrench size

C. Bolt #3

- _____ 1. Bolt size
- _____ 2. Threads per inch
- _____ 3. Bolt length
- _____ 4. Wrench size

B. Bolt #2

- _____ 1. Bolt size
- _____ 2. Threads per inch
- _____ 3. Bolt length
- _____ 4. Wrench size

D. Bolt #4

- _____ 1. Bolt size
- _____ 2. Threads per inch
- _____ 3. Bolt length
- _____ 4. Wrench size

FASTENERS
UNIT IX

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1 — Evaluated to the satisfaction of the instructor

FASTENERS
UNIT IXJOB SHEET #1 — FASTEN TWO PIECES OF METAL WITH HOLLOW
(POP) RIVETS

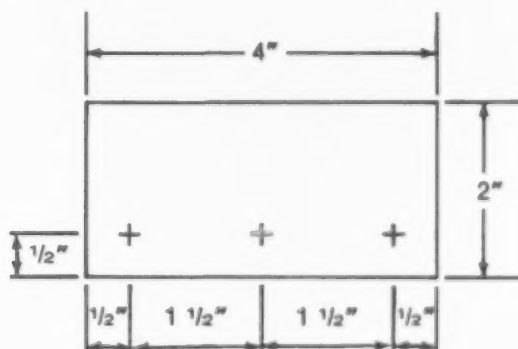
I. Equipment and materials

- A. Two 2" x 4" pieces of 20-gauge sheet metal
- B. Riveting pliers
- C. $\frac{1}{8}$ " blind rivets
- D. $\frac{1}{4}$ " or $\frac{3}{8}$ " hand-drill motor
- E. $\frac{1}{8}$ " drill
- F. Center punch
- G. Shop hammer
- H. Scrap wood, 1" thick
- I. Scriber
- J. Vise or C-clamp
- K. Eye protection
- L. Manufacturer's instruction manual for riveting pliers

II. Procedure

- A. Lay out hole centers as shown in Figure 70 on one piece of sheet metal

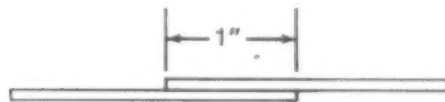
FIGURE 70



JOB SHEET #1

- B. Put on eye protection
- C. Center punch at hole center marks
- D. Place marked piece of sheet metal (center-punched marks up) on top of second piece of sheet metal, allowing for 1 inch overlap (Figure 71)

FIGURE 71



- E. Place scrap wood under sheet-metal pieces, and secure work in vise or secure with a C-clamp to workbench (Figures 72 and 73)

FIGURE 72

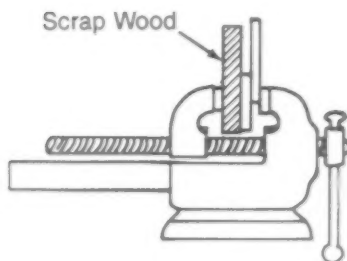
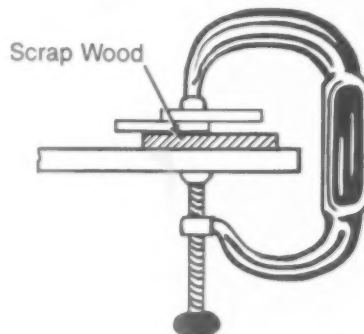


FIGURE 73



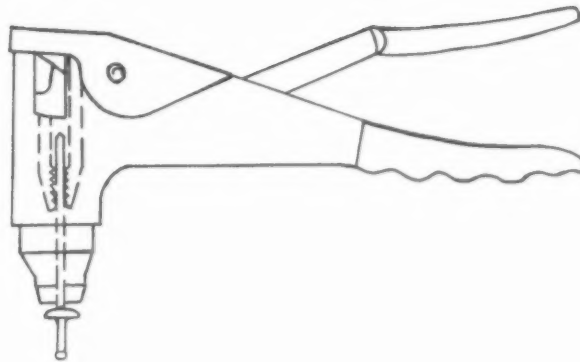
- F. Insert drill in hand-drill motor
- G. Tighten with chuck key
- H. Drill $\frac{1}{8}$ inch holes at center-punched marks

(NOTE: You may not be able to drill three holes because of the vise or C-clamp.)

- I. Remove work from vise or C-clamp
- J. Load riveting pliers, following manufacturer's directions (See Figure 74)

JOB SHEET #1

FIGURE 74



- K. Align holes in the two pieces of metal
- L. Insert rivet into one hole
- M. Squeeze handle of riveting pliers until rivet is set and mandrel shears (pops)
(Figure 75)

FIGURE 75



- N. Repeat procedure until riveting is complete
- O. Clean work area and return equipment and materials to proper storage

FASTENERS UNIT IX

JOB SHEET #2 — REMOVE AND REPLACE A BELT MOLDING

I. Equipment and materials

- A. Vehicle
- B. Replacement belt molding of correct type and size for vehicle
- C. Replacement bolt-attached or screw-attached clips
- D. Masking tape
- E. Body caulking
- F. Phillips screwdriver set
- G. Straight-blade screwdriver set
- H. Ratchet and socket set, $\frac{1}{4}$ " drive
- I. Combination-end wrenches, $\frac{5}{16}$ " to $\frac{9}{16}$ "
- J. Trim stick
- K. Eye protection

II. Procedure

- A. Protect adjacent finishes or molding with masking tape

(NOTE: When removing and replacing any molding or trim, take care to adequately protect all adjacent finishes and moldings with masking tape.)

- B. Examine molding to determine method of attachment and to locate bolt-attached or screw-attached clips (Figures 76 and 77)

(NOTE: There is usually a bolt-attached or screw-attached clip at each end of the belt molding.)

FIGURE 76: T-Bolt Clip and Nut

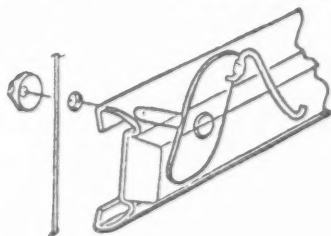
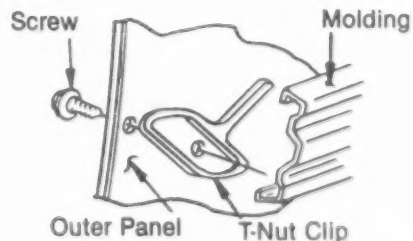


FIGURE 77: Screw-Attached Clip



Figures 76 and 77 used with permission of Fisher Body Division, General Motors Corporation.

JOB SHEET #2

- C. Remove screws or bolts and nuts from clips at ends of belt molding if applicable
- D. As screws or bolts and nuts are removed, stick them to a piece of masking tape and set aside for reinstallation
- E. Determine type and location of snap-on clips

(NOTE: Some belt moldings are adhesive bonded. For removing and reinstalling adhesive-bonded moldings, follow procedures outlined in Job Sheet #8.)

- F. Put on eye protection
- G. Use trim stick to carefully pry molding off snap-on clips as shown in Figures 78 and 79

(NOTE: Molding and clip styles vary on different makes and models of vehicles, but they are removed and reinstalled using the same method.)

CAUTION

Use the correct tool for the job. To prevent damage to molding or retainer clip, always pry off moldings at the clip with a trim stick—not with a screwdriver or any other inappropriate tool.

FIGURE 78

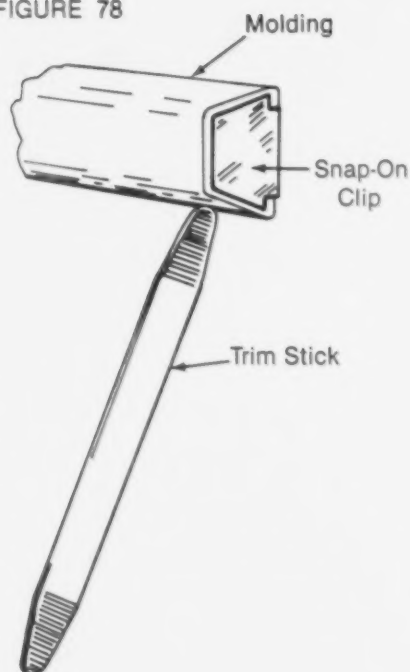
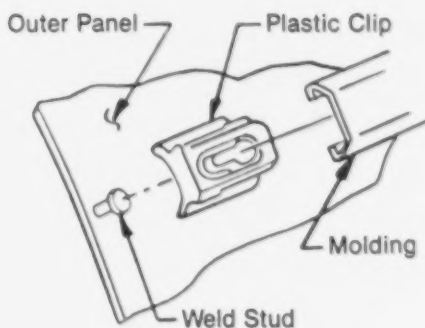


FIGURE 79



Used with permission of Fisher Body Division, General Motors Corporation.

JOB SHEET #2

- H. Examine and replace all damaged clips; install new clips if necessary

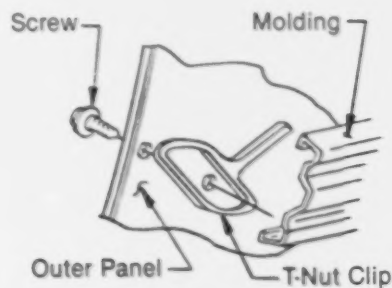
(NOTE: Salvage all extra clips for future use.)

- I. To prevent damage to molding, paint, and panel edges, check to be sure that new molding will clear adjacent panels
- J. Snap new molding in place
- K. Reinstall screws or bolts and nuts in clips at ends of belt molding if applicable, making sure to seal with body caulking (Figure 80)

CAUTION

All screw, bolt, or clip holes must be sealed with body caulking to prevent water from entering the body interior.

FIGURE 80



Used with permission of Fisher Body Division, General Motors Corporation.

- L. Remove eye protection and inspect completed job to make sure that belt molding is secure
- M. Remove protective masking tape
- N. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IX

JOB SHEET #3 — REMOVE AND REPLACE A ROCKER-PANEL MOLDING

I. Equipment and materials

- A. Vehicle
- B. Replacement rocker panel molding of correct type and size for vehicle
- C. Replacement molding retainer clips
- D. Masking tape
- E. Body caulking
- F. Phillips screwdriver set
- G. Straight-blade screwdriver set
- H. Scratch awl
- I. Trim stick
- J. Eye protection

II. Procedure

- A. Protect adjacent finish with masking tape

(NOTE: When removing or replacing any molding or trim, take care to adequately protect all adjacent finishes and moldings with masking tape.)

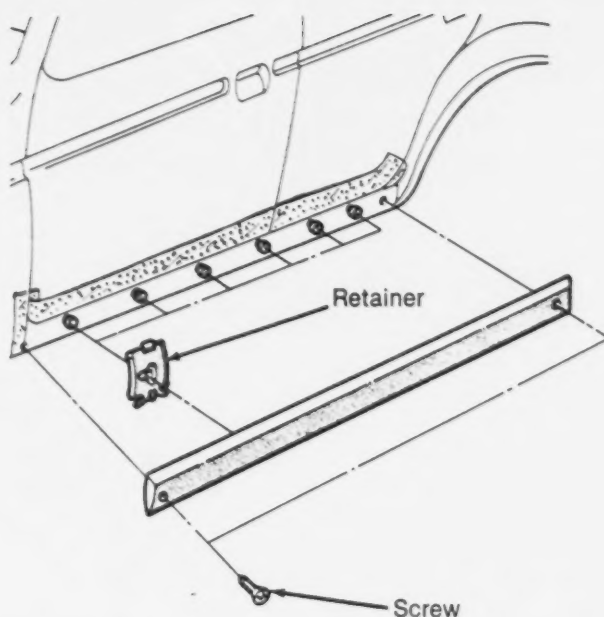
- B. Examine molding to determine method of attachment

(NOTE: Most rocker panels are held at each end by chrome sheet-metal screws. The center section of the rocker panel is usually held in place with snap-over clips.)

- C. Remove screws from each end of molding (See Figure 81.)

JOB SHEET #3

FIGURE 81



Used with permission of Chrysler Corporation.

- D. As screws are removed, stick them to a piece of masking tape and set aside for reinstallation
- E. Put on eye protection
- F. Place trim stick between molding and rocker panel and carefully pry molding up and off retainer clips

CAUTION

Use the correct tool for the job. To prevent damage to the molding or retainer clip, always pry off moldings at the clip with a trim stick—*not* with a screwdriver or any other inappropriate tool.

- G. Remove molding and set aside where it will not be stepped on or damaged
- H. Make necessary body repairs
- I. Examine and replace all damaged retainer clips; install new clips as necessary
(NOTE: Salvage all extra clips for future use.)
- J. To prevent damage to molding, paint, and panel edges, check to be sure that new molding will clear adjacent panels

JOB SHEET #3

K. Install new rocker-panel molding

1. Hook molding over top of retainer clips and adjust to correct position
2. Rotate molding downward and snap over bottom of retainer clips
3. Line up screw holes with a scratch awl if necessary
4. Install screws at ends of molding, making sure to seal with body caulking

CAUTION

All screw, bolt, or clip holes in the vehicle body must be sealed with body caulking to prevent water from entering the body interior.

L. Remove eye protection and inspect job to make sure that molding is secure

M. Remove protective masking tape

N. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IX

JOB SHEET #4 — REMOVE AND REPLACE A WHEEL-OPENING MOLDING

I. Equipment and materials

- A. Vehicle
- B. Replacement wheel-opening molding
- C. Safety stand
- D. Jack
- E. Lug-nut wrench
- F. Masking tape
- G. Body caulking
- H. Phillips screwdriver set
- I. Straight-blade screwdriver set
- J. Scratch awl
- K. Trim stick
- L. Eye protection

II. Procedure

- A. Put on eye protection
- B. If necessary, remove wheel from vehicle to provide clearance for molding removal
- C. Protect adjacent finish with masking tape

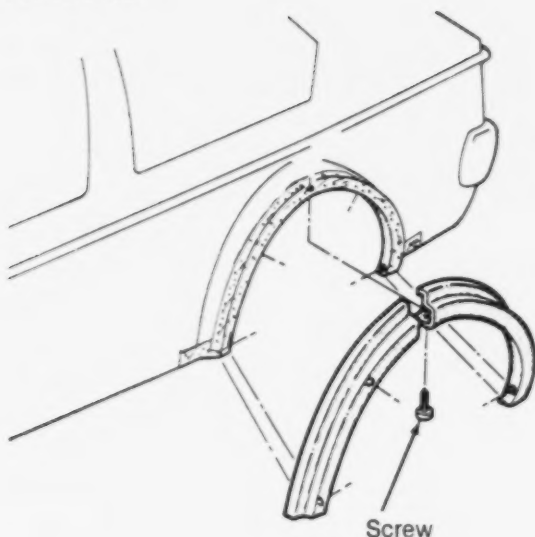
(NOTE: When removing or replacing any molding or trim, take care to adequately protect all adjacent finishes and moldings with masking tape.)

- D. Remove screws (See Figure 82)

(NOTE: Wheel-opening moldings are attached to the body panel with chrome sheet-metal screws.)

JOB SHEET #4

FIGURE 82



Used with permission of Chrysler Corporation.

- E. As screws are removed, stick them to a piece of masking tape and set aside for reinstallation
- F. Use trim stick to gently loosen molding at wheel opening

CAUTION

Use the correct tool for the job. To prevent damage to the molding, always pry off with a trim stick—*not* with a screwdriver or any other inappropriate tool.

- G. Remove wheel-opening molding and set aside where it will not be tripped over or damaged
- H. Make necessary body repairs
- I. Install new molding
 - 1. Place molding in position
 - 2. Line up screw holes with a scratch awl if necessary
 - 3. Start all screws, making sure to seal with body caulking

CAUTION

All screw, bolt, or clip holes in the vehicle body must be sealed with body caulking to prevent water from entering the body interior.

JOB SHEET #4

- 4. Tighten all screws
- J. Inspect job to make sure that wheel-opening molding is secure
- K. Reinstall wheel if it was removed from vehicle
- L. Remove eye protection and protective masking tape
- M. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IX

JOB SHEET #5 — REMOVE AND REPLACE A WINDSHIELD METAL REVEAL
MOLDING

I. Equipment and materials

- A. Vehicle with metal reveal molding around windshield
- B. Replacement molding
- C. Replacement molding retainer clips
- D. Masking tape
- E. Protective cover for hood and fenders
- F. Body caulking
- G. Squeegee
- H. Drill motor
- I. Drill, sized for self-sealing screws
- J. Self-sealing screws
- K. Phillips screwdriver set
- L. Straight-blade screwdriver set
- M. Scratch awl
- N. Reveal molding clip tool
- O. Putty knife
- P. Eye protection

II. Procedure

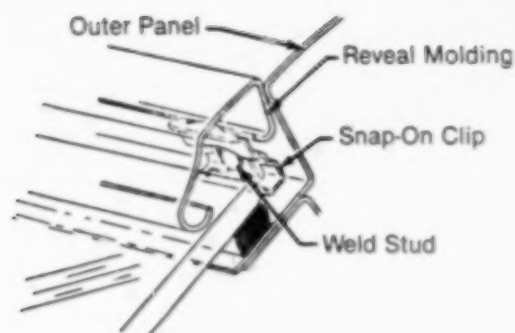
(NOTE: The steps outlined in this job sheet may also be applied to removal and replacement of metal reveal moldings on a back window or stationary quarter window. For removal and replacement of vinyl reveal moldings held in place with a special adhesive, refer to the vehicle service manual.)

A. Examine molding to determine method of attachment

(NOTE: Metal reveal moldings are retained by screw-attached or stud-attached clips. A projection on the clip holds the molding flange, which retains the molding between the clip and the body panel. See Figure 83.)

JOB SHEET #5

FIGURE 83



Used with permission of Fisher Body Division, General Motors Corporation.

B. Protect adjacent finish with masking tape

(NOTE: When removing or replacing any molding or trim, take care to adequately protect all adjacent finishes and moldings with masking tape.)

C. Place protective cover over hood and fenders

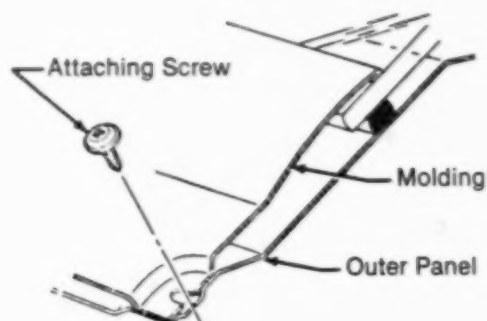
D. Put on eye protection

E. Remove windshield upper and lower reveal moldings

1. Screw-attached lower molding

(NOTE: On some makes and models, the moldings across the bottom of the windshield are retained with sheet-metal screws. See Figure 84.)

FIGURE 84



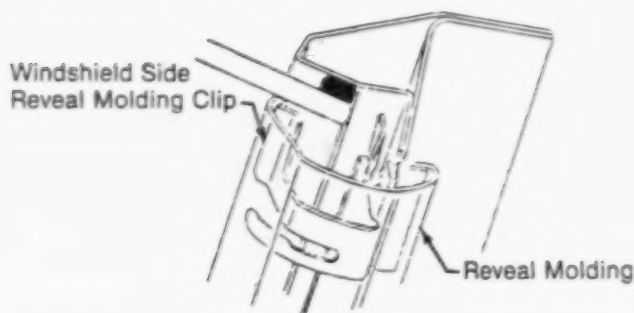
Used with permission of Fisher Body Division, General Motors Corporation.

JOB SHEET #5

- a. Remove all screws
 - b. As screws are removed, stick them to a piece of masking tape and set aside
 - c. Remove molding, tape screws to it, and set aside where it will not get stepped on or damaged
2. Clip-retained lower and upper moldings
- a. Insert reveal molding clip tool between molding and glass
 - b. Hook tool behind retainer clip
 - c. Pull to disengage molding from clip
 - d. Remove molding and set aside where it will not get stepped on or damaged
- F. Remove windshield reveal moldings, following same procedure as that for clip-retained moldings

(NOTE: On some models, side reveal moldings must be removed by inserting a putty knife between the molding and the body on the windshield side to disengage barbed clips. See Figure 85.)

FIGURE 85



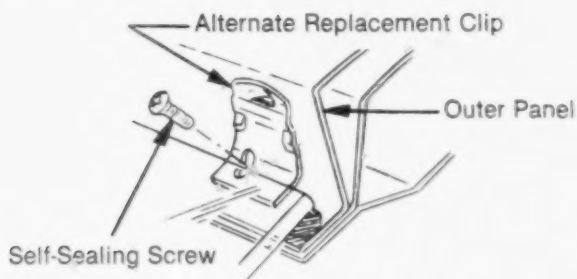
Used with permission of Fisher Body Division, General Motors Corporation.

- G. Make all necessary repairs
- H. If clips were attached with studs, and if weld-stud is damaged or broken, use the following repair procedure
1. Drill a small hole next to original weld-stud location

JOB SHEET #5

2. Insert a self-sealing screw through original or replacement clip (Figure 86)

FIGURE 86



Used with permission of Fisher Body Division, General Motors Corporation.

- I. Examine and replace all damaged retainer clips; install new clips as necessary

(NOTE: Salvage extra clips for future use.)

- J. Install new reveal moldings

1. Clip-retained moldings

- a. Hook molding over top of retainer clips and adjust to proper position
- b. Rotate molding downward and snap over bottom of retainer clips

CAUTION

Use hand pressure only. Reveal moldings are easily damaged.

2. Screw-attached lower molding

- a. Place molding in position
- b. Line up screw holes with scratch awl if necessary
- c. Install screws in molding, making sure to seal with body caulking

CAUTION

All screw, bolt, or clip holes in the vehicle body must be sealed with body caulking to prevent water from entering the body interior.

JOB SHEET #5

- K. Remove eye protection and inspect job to make sure that moldings are properly screwed on or snapped behind all clips
- L. Clean window glass with squeegee and clean water
- M. Remove protective masking tape and hood and fender covers
- N. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IX

JOB SHEET #6 — REMOVE AND REPLACE A DRIP-RAIL SCALP MOLDING

I. Equipment and materials

- A. Vehicle
- B. Replacement drip-rail scalp molding
- C. Phillips screwdriver set
- D. Straight-blade screwdriver set
- E. Masking tape
- F. Body caulking
- G. Scratch awl
- H. Eye protection

II. Procedure

- A. Examine molding to determine method of attachment

(NOTE: Molding styles and methods of attachment vary with different makes and models. A careful examination may prevent damage to the moldings. This job sheet outlines the procedure for removing scalp molding that is screwed to the windshield pillar and upper rear body lock pillar and snapped to the drip rail.)

- B. Protect adjacent finish with masking tape

(NOTE: When removing or replacing any molding or trim, take care to adequately protect all adjacent finishes and moldings with masking tape.)

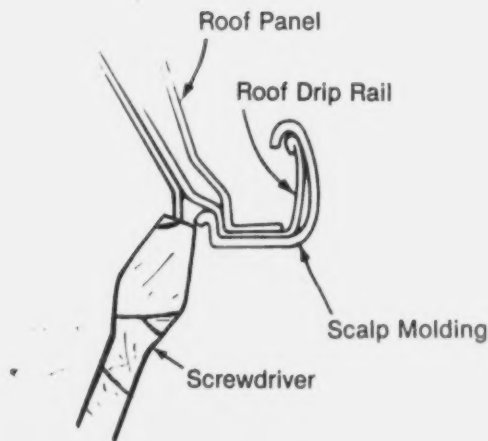
- C. Remove screws securing scalp molding to windshield pillar
- D. As screws are removed, stick them to a piece of masking tape
- E. Carefully remove scalp molding from windshield pillar, tape screws to molding, and set aside so that it will not get stepped on or damaged
- F. Remove screws securing scalp molding to upper rear body lock pillar
- G. As screws are removed, stick them to a piece of masking tape

JOB SHEET #6

- H. Carefully remove scalp molding from lock pillar, tape screws to molding, and set aside so that it will not get stepped on or damaged
- I. Put on eye protection
- J. Remove drip-rail scalp molding
 - 1. Wrap end of flat-blade screwdriver with masking tape
 - 2. Use wrapped end of screwdriver to carefully unsnap scalp molding from drip rail (Figure 87)

(NOTE: It is acceptable to use a screwdriver to unsnap the drip-rail scalp molding because a trim stick would not be strong enough for the job; however, the end of the screwdriver must be wrapped with masking tape to prevent damage to the vehicle finish and the molding.)

FIGURE 87



- 3. Set drip-rail scalp molding aside so that it will not get stepped on or damaged
- K. Make all necessary repairs
- L. Install new drip-rail scalp molding
 - 1. Hook molding over top of drip rail
 - 2. Adjust molding to correct position, making sure that ends are accurately positioned

JOB SHEET #6

3. Rotate molding downward and snap under bottom of drip-rail

CAUTION

To prevent damage to molding, use hand pressure only.

4. Examine molding to be sure that it is properly positioned
- M. Place rear scalp molding in correct position on upper rear lock pillar
- N. Line up screw holes with scratch awl if necessary
- O. Install screws in molding, making sure to seal with body caulking

CAUTION

All screw, bolt, or clip holes in the vehicle body must be sealed with body caulking to prevent water from entering the body interior.

- P. Place windshield pillar scalp molding in correct position on pillar
- Q. Line up screw holes with scratch awl if necessary
- R. Install screws in molding, making sure to seal with body caulking
- S. Remove eye protection and inspect job for proper installation
- T. Remove protective masking tape from vehicle and screwdriver
- U. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IX

JOB SHEET #7 — REMOVE AND REPLACE AN EMBLEM OR NAMEPLATE

I. Equipment and materials

- A. Vehicle
- B. Replacement emblem or nameplate
- C. Oil-free naphtha and clean rags
- D. Phillips screwdriver set
- E. Straight-blade screwdriver set
- F. Ratchet and socket set, $\frac{1}{4}$ " drive
- G. Body caulking
- H. Masking tape
- I. Emblem adhesive

(NOTE: Refer to vehicle service manual or local supplier for recommended adhesive.)

- J. Putty knife
- K. Replacement bayonet clips as necessary
- L. Eye protection

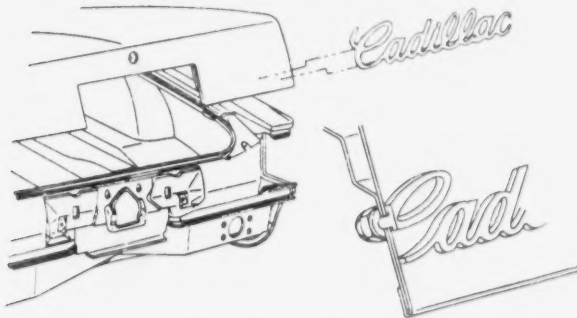
II. Procedure

- A. Determine method used to attach nameplate or emblem to panel

(NOTE: Regardless of their locations, emblems and nameplates on the same vehicle will be attached in one of three ways: integral stud and nut [Figure 88], integral stud and bayonet clip [Figure 89], or adhesive backing [Figure 90].)

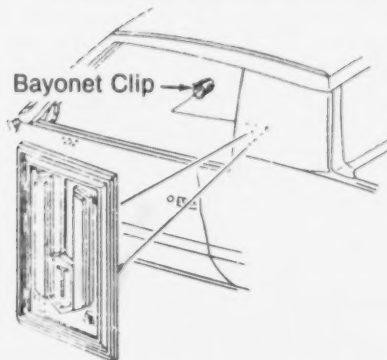
JOB SHEET #7

FIGURE 88: Integral Stud and Nut Attachment



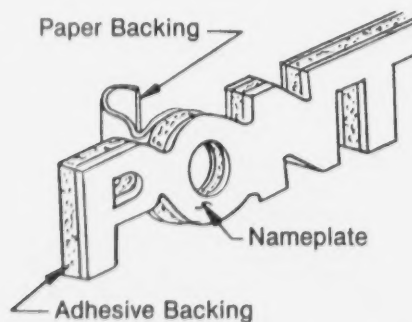
Used with permission of Fisher Body Division, General Motors Corporation.

FIGURE 89: Integral Stud and Bayonet Clip Attachment



Used with permission of Fisher Body Division, General Motors Corporation.

FIGURE 90: Adhesive Backed Attachment



Used with permission of Fisher Body Division, General Motors Corporation.

JOB SHEET #7

- B. Place masking tape around emblem or nameplate to prevent unnecessary damage to surface of panel or vinyl roof
- C. Remove nameplate or emblem from panel or roof
 - 1. Nameplate or emblem attached with integral stud and nut
 - a. If necessary, loosen panel or remove a piece of interior trim to gain access to attaching nuts
 - b. Remove nuts from nameplate or emblem
 - c. Tape nuts to nameplate or emblem and set aside in a safe location
 - 2. Nameplate or emblem attached with integral stud and bayonet clip or with adhesive backing
 - a. Carefully pry nameplate or emblem off panel or roof with a putty knife or other wide-bladed instrument
 - b. Set aside in a safe location
- D. Make necessary repairs
- E. Install new nameplate or emblem
 - 1. Nameplate or emblem attached with integral stud and nut
 - a. Place nameplate or emblem in position
 - b. Install nuts on studs and tighten until just snug

CAUTION

Do not overtighten nuts. Studs are easily broken off.

 - c. Retighten panel or replace any trim that may have been removed to gain access to nuts
 - 2. Nameplate or emblem attached with integral stud and bayonet clip
 - a. Reinstall any bayonet clips removed from panel during body repairs
 - b. Press studs on nameplate or emblem into bayonet clip

JOB SHEET #7

3. New nameplate or emblem attached with adhesive backing
 - a. Clean surface of panel or roof with naphtha and a clean rag
 - b. Peel off backing paper and press nameplate or emblem firmly into position
4. Used nameplate or emblem attached with adhesive backing
 - a. Clean surface of panel or roof and back of nameplate or emblem with naphtha and clean rag
 - b. Apply emblem adhesive to back of nameplate or emblem according to product manufacturer's instruction
 - c. Press nameplate or emblem firmly into place
 - d. Allow adhesive to dry for length of time indicated by manufacturer of product
- F. Remove eye protection and inspect job for proper installation
- G. Remove protective masking tape from around emblem or nameplate
- H. Clean work area and return equipment and materials to proper storage

FASTENERS
UNIT IXJOB SHEET #8 — REMOVE AND REPLACE ADHESIVE-BONDED SIDE
MOLDING

I. Equipment and materials

- A. Vehicle
- B. Replacement molding
- C. Vehicle service manual
- D. Bucket of detergent solution
- E. Clean cloths
- F. Oil-free naphtha or alcohol
- G. Masking tape
- H. Straight-blade screwdriver
- I. Trim molding adhesive

(NOTE: Refer to vehicle service manual or local supplier for recommended adhesive.)

- J. Heat lamp or heat gun
- K. Eye protection

II. Procedure

- A. Examine molding

(NOTE: If molding is not damaged and is to be reinstalled, use extreme care in removal to avoid damage.)

- B. Gently pry up one end of molding and carefully pull molding from panel
- C. Place molding in a safe place on its nonadhesive surface
- D. Put on eye protection
- E. Repair panel if necessary

(NOTE: If backing tape remains on panel surface when molding is removed, and if it does not interfere with repairs, do not remove tape. After panel repairs are complete, clean back of molding and tape surface with naphtha or alcohol and proceed to step F 3.)

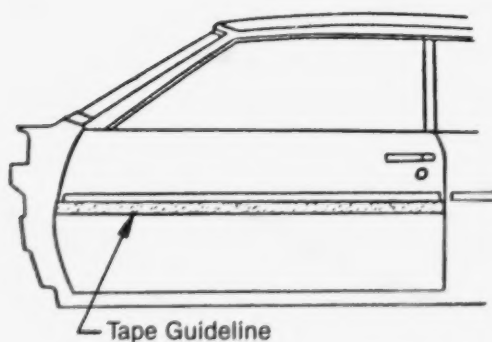
JOB SHEET #8

F. Install new molding

(NOTE: The following method of installation applies only to moldings attached to the panel with adhesive foam or butyl tape.)

1. Wash panel with detergent and water and wipe dry with a clean cloth
2. Using moldings on adjacent panels as a guide, run a strip of masking tape across panel to mark position of bottom edge of molding
3. Position molding on panel, using masking tape strip as a guide (Figure 91)

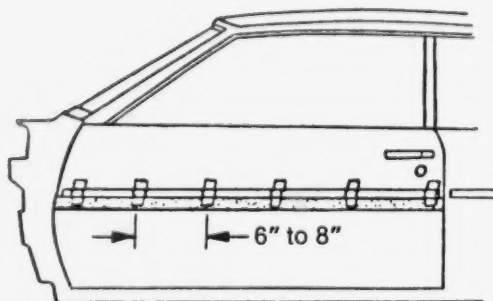
FIGURE 91



Used with permission of Fisher Body Division, General Motors Corporation.

4. Apply strips of masking tape as shown in Figure 92 approximately every 6 inches to 8 inches to hold molding in position

FIGURE 92

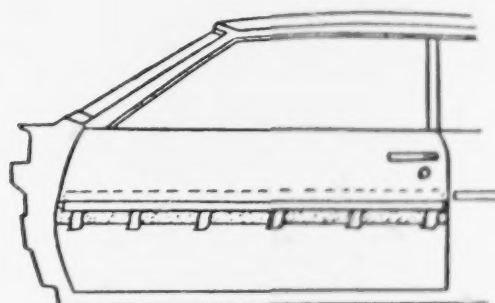


Used with permission of Fisher Body Division, General Motors Corporation.

JOB SHEET #8

5. If panel surface is not at least 70° F, warm the surface with a heat lamp or heat gun
6. Unstick top edges of adhesive tape strips so that molding hinges downward, exposing its adhesive side (Figure 93)

FIGURE 93



Used with permission of Fisher Body Division, General Motors Corporation.

7. Using a circular motion, quickly apply a thin film of adhesive along tape or adhesive line on molding
 8. Realign molding with masking tape guide previously installed, and firmly press molding into place as quickly as possible
 9. Reattach upper ends of masking tape strips (add more tape if necessary) to hold molding in place
 10. Allow adhesive at least fifteen minutes to set up before proceeding to next step
- G. Clean excess adhesive from molding and panel with a clean cloth dampened with naphtha
- H. Remove all masking tape
- (NOTE: Moldings will remain in place after a fifteen-minute cure time. Total cure time is approximately twenty-four hours, and the vehicle should not be exposed to extreme weather or car washes for this period of time.)
- I. Remove eye protection and inspect job for correct installation
 - J. Clean work area and return equipment and materials to proper storage

FASTENERS UNIT IX

TEST

NAME _____

SCORE _____

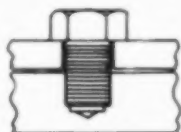
1. Match terms associated with fasteners to their correct definitions. Write the correct numbers in the blanks.

- | | |
|--|------------------------|
| _____ a. Unified National Coarse (UNC) or United States Standard (USS) threads used on bolts and nuts designed to hold soft or crumbly metals in place | 1. Coarse thread |
| _____ b. Bolt or screw designed to cut its own threads in a drilled hole | 2. Self-tapping thread |
| _____ c. Nut designed to lock itself to a bolt to prevent loosening due to vibration | 3. Fine thread |
| _____ d. United National Fine (UNF) or Society of Automotive Engineers (SAE) threads used on bolts and nuts designed for great strength and accuracy | 4. Grade |
| _____ e. Hardness of bolts; indicated by strength markings on heads of customary bolts and numbers on heads of metric bolts | 5. Self-locking nut |

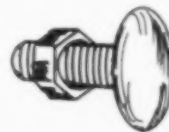
2. Identify the following types of bolts used in body and chassis construction and repair. Write the correct names in the blanks.

Hex-head bolt and nut
Stud
Carriage bolt and nut

Round-head bumper bolt
Elliptical-head bumper bolt
Cap screw



a. _____



b. _____



c. _____

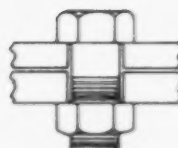


d. _____

TEST



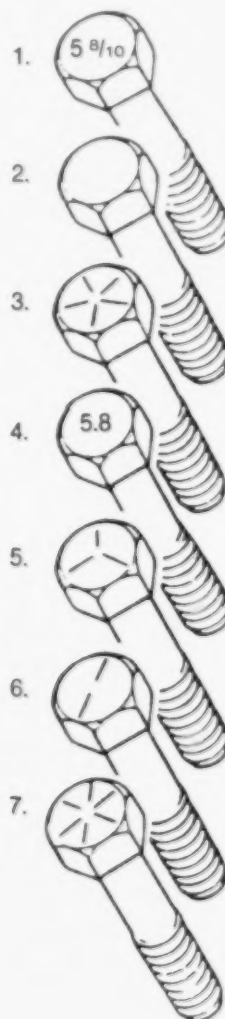
e. _____



f. _____

3. Match customary and metric bolts to their correct grading systems and markings. Write the correct numbers in the blanks.

- _____a. Customary system; grades 1 and 2
 _____b. Customary system; grade 5
 _____c. Customary system; grade 7
 _____d. Customary system; grade 8
 _____e. Metric system



TEST

4. Identify the following types of nuts commonly used in body and chassis construction and repair. Write the correct names in the blanks.

Acorn nut

Hex nut

Castle (castellated) nut

Flanged locknut

Prevailing torque locknut

Slotted hex nut

Square nut

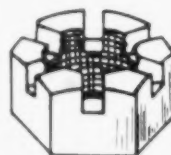
Plastic insert locknut

Flanged hex nut

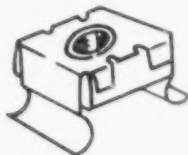
Retainer nut



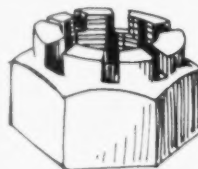
a. _____



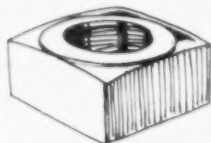
b. _____



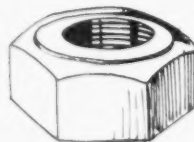
c. _____



d. _____



e. _____



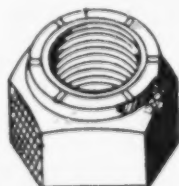
f. _____



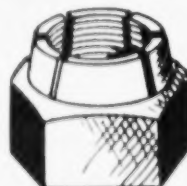
g. _____



h. _____



i. _____



j. _____

TEST

5. Identify the following types of washers commonly used in body and chassis construction and repair. Write the correct names in the blanks.

Body washer

Flat washer

Fender washer

Internal-toothed lock washer

Spring lock washer

External-toothed lock washer

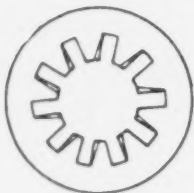
**Countersink, external-toothed
lock washer**



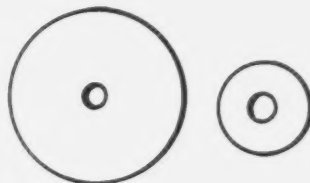
a. _____



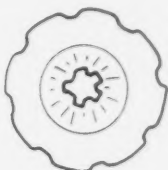
b. _____



c. _____



d. _____



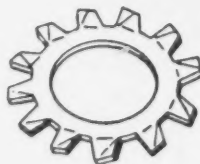
e. _____



f. _____



g. _____



h. _____

TEST

6. Identify the following types of screws commonly used in body and chassis construction and repair. Write the correct names in the blanks.

a. Machine screws

Oval
Round
Flat
Binding

Truss
Hexagon
Hexagon slot
Fillister



1) _____



3) _____



5) _____



7) _____



2) _____



4) _____



6) _____



8) _____

TEST

b. Sheet-metal screws

Flat
Oval
Truss

Hexagon slot
Round
Pan



1) _____



2) _____



3) _____



4) _____



5) _____



6) _____

7. List methods of removing nuts and bolts that are seized due to rust or corrosion.

a. _____

b. _____

TEST

- c. _____

- d. _____

- e. _____

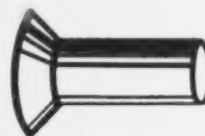
8. Identify the following types of rivets commonly used body and chassis construction and repair. Write the correct names in the blanks.

Hollow (pop) rivet
 Split rivet
 Countersink rivet
 Hollow rivet

Plastic self-locking rivet
 Shoulder rivet
 General-purpose rivet (oval)



a. _____



b. _____



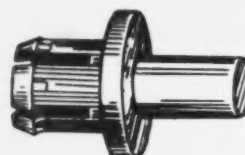
c. _____



d. _____



e. _____



f. _____

TEST



g. _____

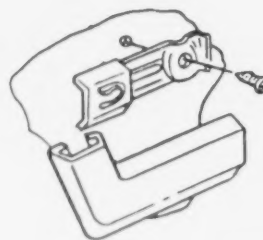
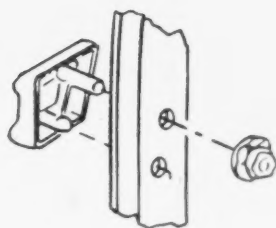
9. List methods of attaching exterior molding and trim.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____

10. Identify common types of exterior molding and trim fasteners. Write the correct names in the blanks.

Tape or sealant
 Integral stud and nut
 Screw
 Screw-attached reveal
 molding clip
 Attaching screw and clip
 Weld-stud clip
 Slide-on clip

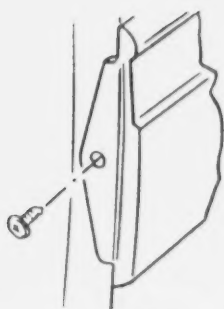
T-bolt or spring-bolt clip
 W-base clip
 Bayonet clip
 Pinch-weld clip
 Joint clip
 Snap-on clip
 T-nut clip



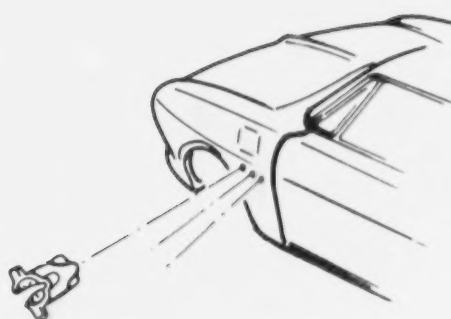
a. _____

b. _____

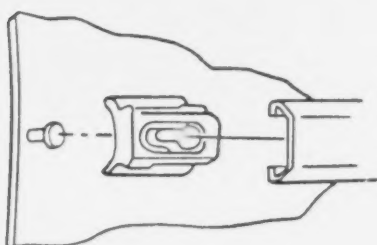
TEST



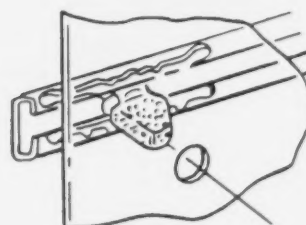
c. _____



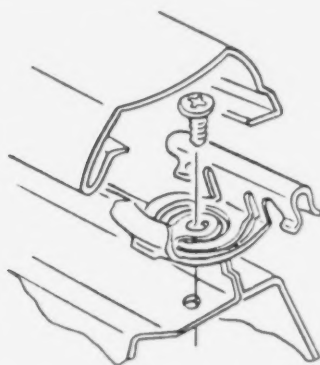
d. _____



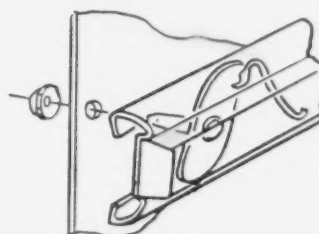
e. _____



f. _____

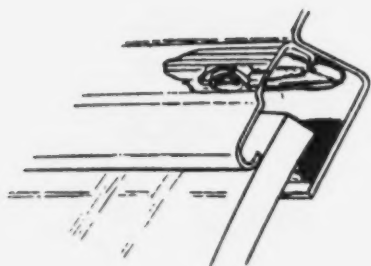


g. _____

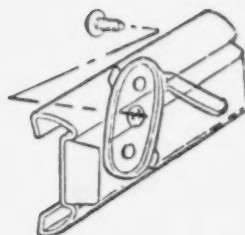


h. _____

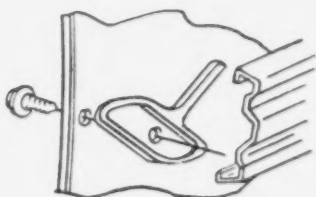
TEST



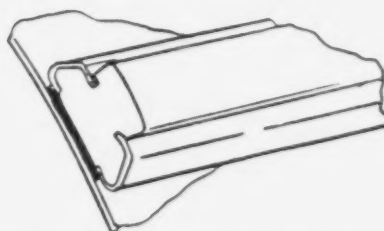
i. _____



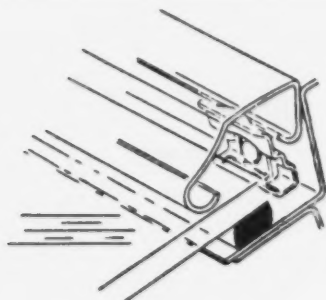
j. _____



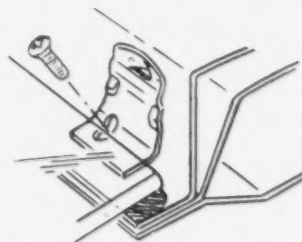
k. _____



l. _____



m. _____



n. _____

(NOTE: Test questions 11 and 12 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

11. Determine bolt and wrench sizes.

TEST

12. Demonstrate the ability to
 - a. Fasten two pieces of metal with hollow (pop) rivets.
 - b. Remove and replace a belt molding.
 - c. Remove and replace a rocker-panel molding.
 - d. Remove and replace a wheel-opening molding.
 - e. Remove and replace a windshield metal reveal molding.
 - f. Remove and replace a drip-rail scalp molding.
 - g. Remove and replace an emblem or nameplate.
 - h. Remove and replace adhesive-bonded side molding.

FASTENERS
UNIT IX

ANSWERS TO TEST

1. a. 1
b. 2
c. 5
d. 3
e. 4
2. a. Cap screw
b. Elliptical-head bumper bolt
c. Stud
d. Round-head bumper bolt
e. Carriage bolt and nut
f. Hex-head bolt and nut
3. a. 2
b. 5
c. 3
d. 7
e. 4
4. a. Flanged hex nut
b. Slotted hex nut
c. Retainer nut
d. Castle (castellated) nut
e. Square nut
f. Hex nut
g. Acorn nut
h. Flanged locknut
i. Plastic insert locknut
j. Prevailing torque locknut
5. a. Flat washer
b. Countersink, external-toothed lock washer
c. Internal-toothed lock washer
d. Fender washer
e. Body washer
f. Body washer
g. Spring lock washer
h. External-toothed lock washer
6. a. Machine screws
 - 1) Oval
 - 2) Hexagon slot
 - 3) Flat
 - 4) Fillister
 - 5) Round
 - 6) Truss
 - 7) Hexagon
 - 8) Binding
b. Sheet-metal screws
 - 1) Round
 - 2) Oval
 - 3) Hexagon slot
 - 4) Pan
 - 5) Flat
 - 6) Truss
7. a. Applying penetrating oil around bolt threads where they protrude through nut, and then removing nut with a wrench
b. Splitting nut with a cold chisel and hammer in situations where access space is limited or rust or corrosion is too severe for penetrating oil to be effective
c. Sawing nut away from bolt with a hacksaw when adequate space is available
d. Cracking nut with a nut splitter—a tool specially designed to remove seized nuts
e. Using an oxyacetylene torch to expand nut by heating it red hot and then removing it with a wrench, or using a cutting torch attachment to cut off bolt or nut

ANSWERS TO TEST

8.
 - a. General-purpose rivet (oval)
 - b. Countersink rivet
 - c. Split rivet
 - d. Hollow rivet
 - e. Shoulder rivet
 - f. Plastic self-locking rivet
 - g. Hollow (pop) rivet

9.
 - a. Adhesive
 - b. Integral studs and nuts
 - c. Screws
 - d. Clips
 - e. Screws and clips
 - f. Snap-over components

10.
 - a. Integral stud and nut
 - b. Joint clip
 - c. Screw
 - d. Bayonet clip
 - e. Weld-stud clip
 - f. W-base clip
 - g. Pinch-weld clip
 - h. T-bolt or spring-bolt clip
 - i. Slide-on clip
 - j. Attaching screw and clip
 - k. T-nut clip
 - l. Tape or sealant
 - m. Snap-on clip
 - n. Screw-attached reveal molding clip

11. Evaluated to the satisfaction of the instructor

12. Performance skills evaluated to the satisfaction of the instructor

CIRCUITS AND WIRES UNIT X

UNIT OBJECTIVE

After completing this unit, the student should be able to check, troubleshoot, and service an automotive electrical system. The student will show this knowledge by completing the job sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with circuits and wires.
2. Match common electrical symbols to their correct representations.
3. List basic components of a simple circuit.
4. Match current, voltage, and resistance to their correct units of measure.
5. List types of electrical test equipment.
6. Identify types of circuits.
7. Arrange in order the steps for checking an electrical circuit from battery to ground.
8. Arrange in order the steps for troubleshooting an electrical system.
9. List automotive electrical system safety rules.
10. Match types of wire connectors (terminals) to their correct names.
11. Name types of wire splices.
12. Distinguish between single-filament and double-filament bulbs used in automotive lamp assemblies.
13. Demonstrate the ability to
 - a. Check battery voltage.
 - b. Check circuit continuity.
 - c. Install a soldered terminal.
 - d. Install a solderless terminal.
 - e. Solder-splice a wire.
 - f. Remove, replace, and align sealed-beam headlights.

CIRCUITS AND WIRES
UNIT X

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Assignment sheets
 - 1. Assignment Sheet #1 — Complete Automotive Electrical System Safety Rules
 - 2. Assignment Sheet #2 — Identify Electrical Symbols on a Wiring Diagram

E. Answers to assignment sheets

F. Job sheets

- 1. Job Sheet #1 — Check Battery Voltage
- 2. Job Sheet #2 — Check Circuit Continuity
- 3. Job Sheet #3 — Install a Soldered Terminal
- 4. Job Sheet #4 — Install a Solderless Terminal
- 5. Job Sheet #5 — Solder-Splice a Wire
- 6. Job Sheet #6 — Remove, Replace, and Align Sealed-Beam Headlights

G. Test

H. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Order or obtain materials planned to supplement unit.
 - 1. Filmstrips

- a. *Headlamp Aiming*, 1 cassette, 1 filmstrip, 1 work sheet; available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628

SUGGESTED ACTIVITIES

(NOTE: This filmstrip describes the proper method of mechanical headlamp aiming, using the Hopkins Lev-L-Lite equipment.)

- b. *Battery Testing*, 1 cassette, 1 filmstrip, 1 work sheet; available from Teaching Aids, Incorporated, P.O. Box 1798, Costa Mesa, California 92628

(NOTE: This filmstrip describes battery ratings, specific gravity, and other related information. Emphasis is placed on the hydrometer test and the high-rate discharge capacity test.)

- c. *Electrical Circuits*, 1 cassette, 1 filmstrip, 1 work sheet, 1 post-test; available from Career Aids, Incorporated, 20417 Nordhoff Street, Department R, Chatsworth, California 91311; phone 818-341-8200
- d. *Voltmeters and Ammeters*, 1 cassette, 1 filmstrip, 1 work sheet, 2 job sheets; available from Career Aids, Incorporated, 20417 Nordhoff Street, Department R, Chatsworth, California 91311; phone 818-341-8200

(NOTE: This filmstrip covers the operation of the voltmeter and ammeter, and how to connect, use safely, and read the various scales of these instruments.)

- e. *Ohmmeter*, 1 cassette, 1 filmstrip, 1 work sheet; available from Career Aids, Incorporated 20417 Nordhoff Street, Department R, Chatsworth, California 91311; phone 818-341-8200

(NOTE: This filmstrip discusses the internal operation and safe use of the ohmmeter, and the difference between no resistance and infinite resistance. Students are taught to read the ohmmeter scale.)

2. Automotive electrical wire of various gauges; various wire connectors (terminals) and bulbs for display and class discussion
3. Test lamp, voltmeter, ammeter, and ohmmeter for demonstration and class discussion
4. Copies of appropriate service manuals
5. Safety films pertaining to electrical hazards
6. Safety materials from OSHA for bulletin board use and class discussion
7. Late-model luxury automobile with many electrical options
8. Various sizes, styles, and shapes of bulbs used in a single automobile
9. Variety of headlight bulbs

SUGGESTED ACTIVITIES

10. Equipment and materials needed to perform job sheets
11. Competency profiles

(NOTE: Competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

- C. Provide students with unit.
- D. Introduce unit.

SUGGESTIONS:

- Explain to students that during collisions, electrical components are often damaged or wires are cut and must be repaired.
- Explain that electrical systems extend throughout the entire automobile; therefore, the auto-body technician must be familiar with electrical systems, electrical schematics, test equipment, and repair procedures. Remind students that all electrical equipment must be in working order when the automobile leaves the body shop.
- Use a late-model luxury automobile with all available electrical options to point out the numerous electrical components that may be contained within the body.

EXAMPLES: Electric door locks, electric window lifts, power antenna, rear window de-icer, electric deck lid release, power seats, lights, radio and speakers, cigarette lighter, instruments

- E. Discuss unit and specific objectives.
- F. Discuss information and assignment sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with automotive electrical systems and repair procedures.

SUGGESTIONS:

- Explain to students that familiarity with electrical terminology will enable them to read and understand vehicle service manuals and electrical schematics, and will improve their communication with others in the trade.
- Use test question 1 as a terminology pretest. Critique pretest and discuss in class, using class discussion to get students involved.

SUGGESTED ACTIVITIES

- Invite a guest speaker—such as an automotive electrical specialist or a factory representative from a company that sells automotive electrical devices to local suppliers—to speak to the class.
 - Plan a field trip to an automotive electric shop if possible.
2. Use Information Sheet, Section II to introduce students to the symbols used to represent electrical components in a schematic drawing.

SUGGESTIONS:

- Allow students a few minutes to review the symbols.
 - Show students samples of electrical schematics, pointing out the various electrical symbols on the drawings. Explain that the symbols on the drawings help the technician locate various electrical components when troubleshooting a circuit.
 - Show students actual components represented by each symbol.
 - Make a set of flash cards containing the symbols and the names of the components that they represent. Use the flashcards with the class as a whole, or pair students and have these teams of two use the flashcards to review the symbols.
 - Have students complete Assignment Sheet #1 to review symbols.
3. Use Information Sheet, Section III to discuss the essential components of a simple circuit.

SUGGESTIONS:

- Use a live model to show the power source (battery), the conductors (wires), and the load (headlight).
 - Show filmstrip *Electrical Circuits*.
4. Use Information Sheet, Section IV to explain factors of electrical flow and how each is measured.

SUGGESTIONS:

- Show filmstrips *Voltmeters and Ammeters* and *Ohmmeter*.
- Using an automobile as a live model, connect an ammeter to demonstrate current being measured in amperes, a voltmeter to demonstrate the measurement of voltage, and an ohmmeter to demonstrate resistance being measured in ohms.

SUGGESTED ACTIVITIES

- Explain the roles that amperes, volts, and ohms play in an electrical circuit.
5. Use Information Sheet, Section V to discuss types of electrical test equipment.

SUGGESTIONS:

- Show filmstrip *Battery Testing*.
 - Show students examples and demonstrate the uses of each piece of test equipment listed in the information sheet. To prevent confusion, demonstrate one test instrument each day for four different days.
6. Use Information Sheet, Section VI to introduce students to the types of electrical circuits in an automotive system.

SUGGESTION:

- Use an automobile as a live model to point out an electrical circuit: Show students a door with electrical window lifts and door locks, comparing this actual circuit with the electrical schematic to match it in the vehicle service manual.
7. Use Information Sheet, Section VII to discuss the steps used to check an electrical circuit from battery to ground.

SUGGESTIONS:

- Using an automobile as a live model, point out the components—junction box, fuse panel, hot wire from power source—in the circuit to be checked.
 - Explain and demonstrate the sequential steps for tracing from the power source to the ground.
8. Use Information Sheet, Section VIII to discuss the steps for troubleshooting an electrical system.

SUGGESTIONS:

- Stress that troubleshooting steps must be followed in sequence in order for the technician to locate the problem in the electrical system and make the repair in the shortest period of time.
- Select an automobile circuit and demonstrate the troubleshooting steps, using a service manual that matches the automobile make and year.

SUGGESTED ACTIVITIES

- After your demonstration and discussion, conduct a question and answer period.
9. Use Information Sheet, Section IX to introduce students to safety rules pertinent to working on automotive electrical systems.

SUGGESTIONS:

- Give students a few minutes to look over Section IX of the information sheet.
 - Show safety films pertaining to electrical devices and equipment.
 - Use OSHA materials for class discussion.
 - Ask the school nurse to talk to the class about how to handle victims of electrical shock and burns. If the school nurse is not available, most fire departments have paramedics who may be available.
 - Ask a representative from the fire department to give a talk on electrical fires and types of fire extinguishers used for electrical fires.
 - Have students complete Assignment Sheet #2 to reinforce their knowledge of safety rules.
10. Use Information Sheet, Section X to illustrate and discuss types of wire connectors.

SUGGESTIONS:

- Show students the different types of wire connectors used on automotive electrical wiring and components.
 - Use a live model to point out the locations of various types of wire connectors.
 - Make a display board of the various types of connectors.
11. Use Information Sheet, Section XI to discuss solder splices and solderless splices.

SUGGESTIONS:

- Show students examples of properly made splices.
- Explain and demonstrate the proper procedure for making a splice.
- Explain that a poorly made splice can lose contact and short out the circuit, causing further damage.

SUGGESTED ACTIVITIES

12. Use Information Sheet, Section XII to discuss types of bulbs used in automobile lamp assemblies.

SUGGESTIONS:

- Show students how to identify double- and single-filament bulbs.
- Show students samples of the various sizes, styles, and shapes of bulbs used in a single automobile.

EXAMPLES: Side marker bulbs, taillight and stoplight bulbs, backup light bulbs, dome light bulbs, instrument panel bulbs, headlight bulbs

- Explain that even though many bulbs of different sizes and shapes are used on an automobile, they are all either single- or double-filament.
- Show students samples of square, round, and rectangular headlight bulbs.
- Show students a halogen bulb, and explain the advantages of halogen bulbs.
- Explain to students that any time a lamp assembly is opened, it must be sealed when reassembled to prevent moisture from entering the lamp.
- Show filmstrip *Headlamp Aiming*.

G. Discuss and demonstrate Job Sheets #1 through #6.

H. Have students complete Job Sheets #1 through #6.

I. Give test.

J. Critique test and discuss in class.

K. Reteach and retest if necessary.

L. Complete appropriate section of competency profiles.

III. Unit references

- A. *Automotive Technology, 1985 Catalog*. Costa Mesa, California: Teaching Aids, Inc., 1985.
- B. Hogg, John W. *Auto Body Repair and Refinishing*. Toronto, Canada: McGraw-Hill Company of Canada, Ltd., 1969.
- C. Hobson, W. T. *Automotive Refinishing Principles and Techniques*, 1st ed. Wilmington, Delaware: E. T. DuPont de Nemours and Co., 1969.

SUGGESTED ACTIVITIES

- D. Foutes, William, et al. *Diesel Mechanics: Electrical Systems*, 2nd ed. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1982.
- E. McPherson, Robert C. *Collision Repair Guide*. New York: McGraw-Hill, Inc., 1971.
- F. *1980 Fisher Body Service Manual*. Warren, Michigan: General Motors Corporation, 1979.
- G. *1982 Shop Manual: Impala, Caprice Classic, Malibu Classic, Monte Carlo and El Camino*. Detroit, Michigan: Chevrolet Motor Division, General Motors Corporation, 1981.
- H. Spicer, Edward D. *Automotive Collision Work*, 4th ed. Chicago, Illinois: American Technical Society, 1972.
- I. *Software and Multimedia Materials for Industrial & Technical Education, 1985 Catalog*. Chatsworth, California: Career Aids, Inc., 1985.
- J. Toboldt, Bill. *Auto Body Repair and Refinishing*. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1972.

CIRCUITS AND WIRES
UNIT X

INFORMATION SHEET

I. Terms and definitions

- A. Circuit — Continuous path along a conductor through which electrical current can flow from a power source through a load and back to the source
- B. Conductor — Any material that allows electrical current to flow through it easily
- C. Insulator — Any material that resists the flow of electrical current, preventing it from leaking (shorting) to another conductor
- D. Load — Object that converts electrical energy into heat, light, or mechanical energy
- E. Direct current (DC) — Steady flow of electrons moving continually in the same direction along a conductor from a point of high potential to one of lower potential
- F. Alternating current (AC) — Flow of electrons in a conductor that reverses direction of flow at intervals
- G. Alternator — Electric generator that produces alternating current
- H. Generator — Electric generator that produces direct current
- I. Grounded circuit — Circuit in which a wire touches ground, causing current to flow to ground instead of through circuit
- J. Open circuit — Circuit in which a wire is broken or disconnected and current is unable to flow
- K. Short circuit — Circuit in which a wire touches another wire and provides a shorter path for current flow

(NOTE: When a circuit shorts, an excessive amount of current flows, resulting in a blown fuse or the activation of a circuit breaker.)
- L. Fuse — Device—usually a glass tube with metal ends connected by a metal strip—designed to melt during an excessive amount of current flow

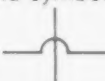
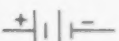
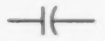
(NOTE: Fuses are rated in amperes and are designed to blow if amperage exceeds the rating of the fuse. This action prevents electrical devices from damage caused by excessive current flow. Never install a fuse with a higher amperage rating than that recommended by the manufacturer.)
- M. Circuit breaker — Mechanical device activated by heat; when amperage exceeds the device's safety rating, a set of contact points opens and stops current flow

INFORMATION SHEET

- N. Condenser (capacitor) — Device that stores extra current to prevent arcing and burning as the contact points open
- O. Connector (terminal) — Device used to attach electrical wires (conductors) to electrical components
- P. Switch -- Device designed to open and close a circuit
- Q. Junction block — Multiple connection point for current or ground; may be used as a test point
- R. Primary wire — Low-tension conductor used for low-voltage ignition, lighting, and accessory circuits
- (NOTE: The primary wire is measured in gauge number. The higher the gauge number, the smaller the wire.)
- S. Secondary wire — High-tension conductor used for high-voltage ignition circuits, as in spark plug and coil wires
- T. Cable — Stranded conductors, usually covered with insulating material
- U. Wiring harness — System of wires that are taped together and designed to supply power to all electrical devices throughout the vehicle
- V. Wiring diagram (schematic) — Drawing that uses electrical symbols to show electrical circuits

II. Common electrical symbols used on schematics and wiring diagrams (Table 1)

TABLE 1 Common electrical symbols

Conductor 	Crossing conductors Old symbol  New symbol 		Connection 	Terminal 
Contact points  or 	Battery One cell  Multicell 		Ground 	Coil  or 
Solenoid  or  or 	Fixed resistor  or 		Variable resistor (rheostat)  or 	
Inductor Old symbol  New symbol 	Iron core inductor 		Condenser (capacitor) 	

INFORMATION SHEET

Ammeter 	Voltmeter 	Switch Open  Closed 	Fuse  or 
Circuit breaker 	Spark gap 	Fusible link or wire 	Incandescent lamp 
Indicator light 	Direct current motor 	Alternating current motor 	Generator 
Alternator 	Direction of current 	Diode (one-way) 	Transistor (PNP) 
Transistor (NPN) 	Zener diode 		

III. Basic components of a simple circuit

A. Power source

EXAMPLE: Battery

B. Load (resistor)

EXAMPLE: Light bulb

C. Conductor

EXAMPLE: Copper wire

IV. Electrical units of measure

A. Current — Flow of electrons measured in amperes

B. Voltage — Electrical pressure measured in volts

C. Resistance — Opposition to current flow measured in ohms

INFORMATION SHEET

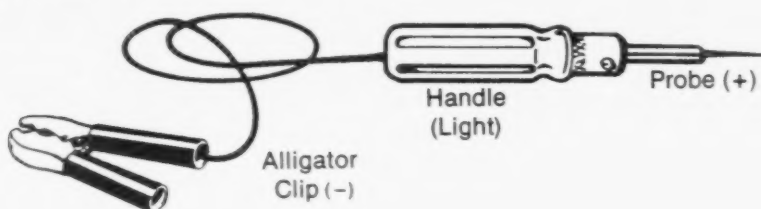
V. Types of electrical test equipment (Figures 1-4)

A. Test lamp

(NOTE: When the test light is on, there is electrical flow in the circuit.)

EXAMPLE:

FIGURE 1

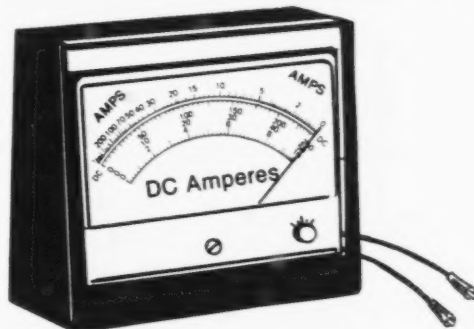


B. Ammeter

(NOTE: The ammeter measures volume of electrical flow in a circuit.)

EXAMPLE:

FIGURE 2

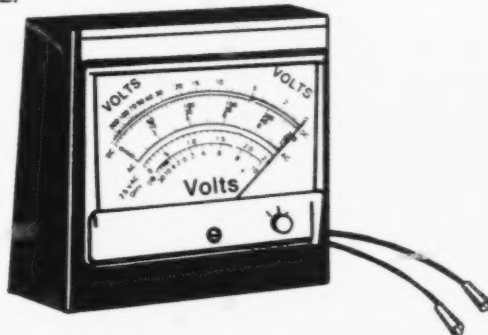


C. Voltmeter

(NOTE: The voltmeter measures electrical pressure.)

EXAMPLE:

FIGURE 3



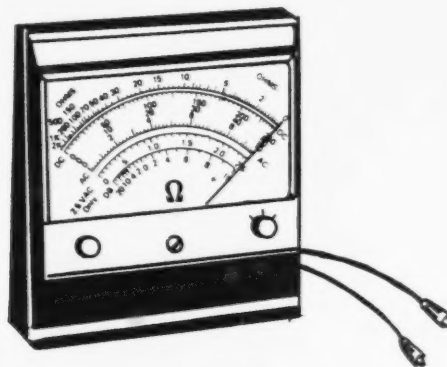
INFORMATION SHEET

D. Ohmmeter

(NOTE: The ohmmeter measures resistance to electrical flow in a circuit.)

EXAMPLE:

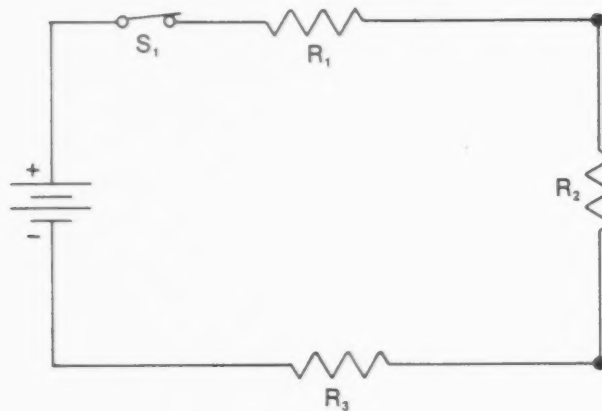
FIGURE 4



VI. Types of electrical circuits (Figures 5-7)

A. Series

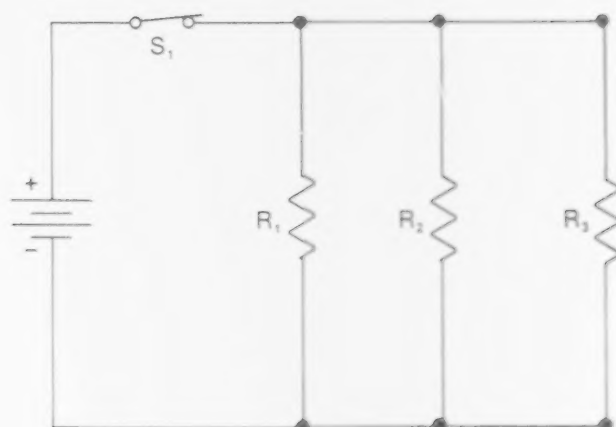
FIGURE 5



INFORMATION SHEET

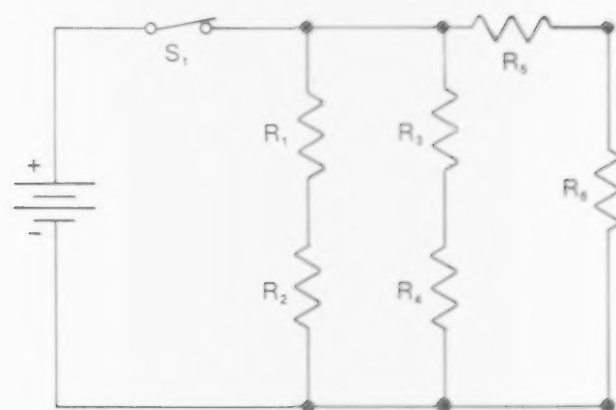
B. Parallel

FIGURE 6



C. Series parallel

FIGURE 7



INFORMATION SHEET

- VII. Steps for checking an electrical circuit from battery to ground
 - A. Locate junction block, fuse panel, or breaker panel
 - B. Identify color coding on wire from power source
 - C. Trace power supply wire from power source to component
 - D. Isolate problem
 - E. Repair as necessary
- VIII. Steps for troubleshooting an electrical system
 - A. Operate circuit to verify complaint
 - B. Read wiring diagram or electrical schematic for circuit to be replaced
 - C. Locate cause of problem
 - D. Repair as necessary
 - E. Recheck circuit to make sure that it is operating properly
- IX. Safety rules to follow when working with automotive electrical systems
 - A. Remove all jewelry before disconnecting battery cables or working on any electrical circuit
 - B. Always remove ground (negative) cable first when disconnecting battery cables
 - C. Always disconnect battery cables before using ohmmeter
 - D. Never leave ignition switch on when installing a distributor
 - E. Never ground output terminal of an alternator
 - F. Never lay a conductor across battery terminals
 - G. Always disconnect battery before replacing an electrical component
 - H. Never apply full battery voltage to a fuel tank sending unit
 - I. When using jumper cables, always connect ground to frame or engine
 - J. When using a battery charger, disconnect battery cables and connect charger to battery before plugging charger into power supply
 - K. Before installing an electrical accessory, make sure that the ground matches that of vehicle polarity

INFORMATION SHEET

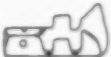
L. When adding accessories, be sure not to exceed charging system output

(NOTE: The charging system should supply an output of 10 percent above the total current draw.)

M. Always replace worn or damaged conductors (wires) with conductors of the same gauge as those being replaced

X. Types of wire connectors (terminals) (Table 2)

TABLE 2 Wire connectors

Ring (eyelet)	Roll	Female plug (bullet)
		
Male plug (bullet)	Female snap-on	Lug
		
Female slide	Male slide	Insulated butt
		
Three-way	Slotted hook	Slotted flange
		

XI. Types of wire splices

(NOTE: When electrical wires are broken or cut due to collision or other damage, it is necessary to splice the severed ends back together to restore the circuit to working order or to prevent shorting, which could cause further damage.)

A. Solder splice

B. Solderless splice

INFORMATION SHEET

XII. Types of bulbs used in automotive lamp assemblies

A. Single-filament

(NOTE: Single-filament bulbs are used in single-purpose lamps.)

1. High-beam sealed-beam headlights
2. Side marker lamps
3. Dome lights
4. Instrument panel lights
5. Truck clearance lights

B. Double-filament

(NOTE: Double-filament bulbs are used in lamp assemblies that serve two or three purposes.)

1. Low-beam/high-beam sealed-beam headlights
2. Taillight/stoplight/turn light lamp assemblies

CIRCUITS AND WIRES
UNIT XASSIGNMENT SHEET #1 — COMPLETE AUTOMOTIVE ELECTRICAL SYSTEM
SAFETY RULES

NAME _____ SCORE _____

Because all electrical equipment must be in working order when a vehicle leaves the body shop, the auto-body technician will be performing repair work on automotive electrical systems. It is very important for the technician to be aware of the hazards and safety precautions associated with automotive electrical systems so that such repair work can be performed safely and efficiently.

Fill in the blanks with the correct word or words to complete the following automotive electrical system safety rules. Treat this assignment sheet as though it were a self-test, and do not refer to the information sheet. When you have completed the assignment sheet, exchange it with a class member, and refer to Information Sheet, Section IX to grade it. Perfect score is 100 percent; each blank—regardless of the number of words it contains—counts 5 points.

- A. Remove all _____ before disconnecting battery cables or working on any electrical circuit
- B. Always remove _____ cable first when disconnecting battery cables
- C. Always disconnect battery cables before using _____
- D. Never leave _____ switch on when installing a _____
- E. Never ground _____ of an alternator
- F. Never lay a _____ across battery terminals
- G. Always _____ battery before _____ an electrical component
- H. Never apply _____ battery voltage to a _____
- I. When using jumper cables, always connect ground to _____
or _____

ASSIGNMENT SHEET #1

- J. When using a battery charger, disconnect battery cables and connect charger to battery before _____
- K. Before installing an electrical accessory, make sure that the _____ matches that of vehicle polarity
- L. When adding _____, be sure not to _____ charging system output
- M. Always replace worn or damaged conductors (wires) with conductors of the _____ as those being replaced

CIRCUITS AND WIRES
UNIT X

ASSIGNMENT SHEET #2 — IDENTIFY ELECTRICAL SYMBOLS ON
A WIRING DIAGRAM

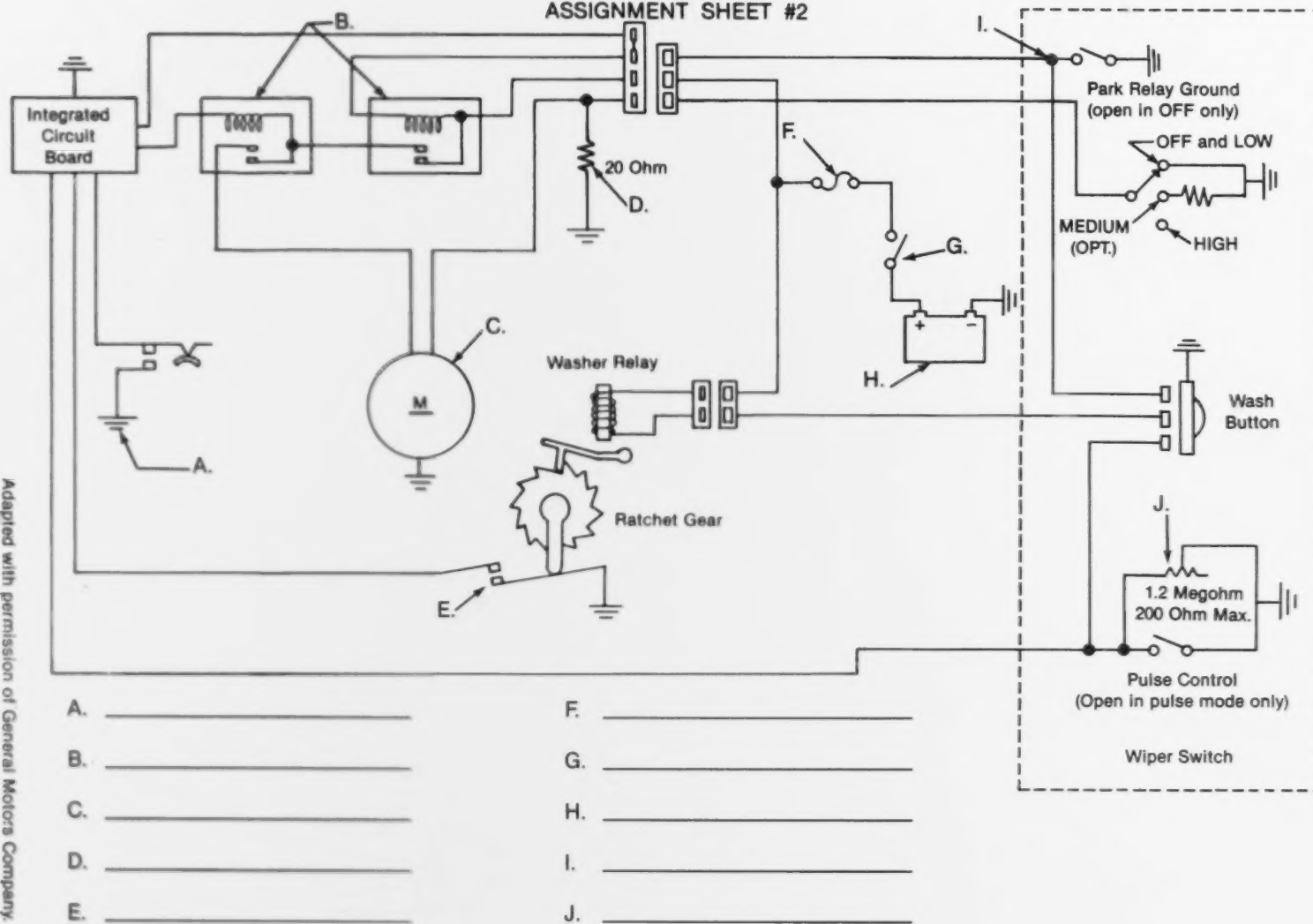
NAME _____

SCORE _____

Most of today's foreign and domestic automobiles and trucks are equipped with various types of electrical devices throughout the entire vehicle. Auto-body technicians must be able to identify electrical symbols in a wiring diagram in order to recognize, locate, and repair all components and devices in a circuit.

Identify the electrical symbols in the wiring diagram of the windshield washer system illustrated on the following page. Write the correct names in the appropriate blanks. Note that the diagram is typical in that it is a combination of symbolic and representational drawings. The washer relay, for instance, is representational, while other relays are depicted in symbol form.

ASSIGNMENT SHEET #2



Adapted with permission of General Motors Company.

CIRCUITS AND WIRES
UNIT X

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

- A. Jewelry
- B. Ground (negative)
- C. Ohmmeter
- D. Ignition, distributor
- E. Output terminal
- F. Conductor
- G. Disconnect, replacing
- H. Full, fuel tank sending unit
- I. Frame, engine
- J. Plugging charger into power supply
- K. Ground
- L. Accessories, exceed
- M. Same gauge

Assignment Sheet #2

- A. Ground
- B. Relay
- C. Direct current motor
- D. Fixed resistor
- E. Contact point
- F. Fuse
- G. Switch (open)
- H. Battery
- I. Connection
- J. Variable resistor

CIRCUITS AND WIRES
UNIT X

JOB SHEET #1 — CHECK BATTERY VOLTAGE

- I. Equipment and materials
 - A. Battery
 - B. Voltmeter
 - C. Eye protection
 - D. Rubber gloves
 - E. Rubber apron
 - F. Appropriate service manual
- II. Procedure
 - A. Remove all jewelry and put on eye protection, rubber gloves, and rubber apron
 - B. Connect negative voltmeter lead to negative battery terminal
 - C. Connect positive voltmeter lead to positive battery terminal

(NOTE: If the battery is new, the negative terminal will be green and the positive terminal will be red. Also, the positive terminal is larger in diameter than the negative terminal, and both terminals will be marked with the symbol for their polarities, + or —.)
 - D. Read voltmeter scale to determine whether battery contains voltage of normal rating according to manufacturer's specifications
 - E. If battery voltage is at full charge, continue with other electrical tests as necessary
 - F. If battery voltage is below normal rating, recharge battery before performing other electrical tests

(NOTE: Refer to Job Sheet #3 in Unit XI, "Battery Service," for correct procedure for charging a battery.)
 - G. Disconnect negative voltmeter lead from negative battery terminal
 - H. Disconnect positive voltmeter lead from positive battery terminal
 - I. Remove eye protection and protective clothing
 - J. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

JOB SHEET #2 — CHECK CIRCUIT CONTINUITY

I. Equipment and materials

- A. Battery
- B. Ohmmeter
- C. Eye protection
- D. Rubber gloves
- E. Rubber apron
- F. Appropriate service manual

II. Procedure

- A. Remove all jewelry and put on eye protection, rubber gloves, and rubber apron
- B. Disconnect negative (ground) cable from battery terminal

CAUTION

The ohmmeter will be damaged if the battery ground cable is not disconnected before connecting the ohmmeter leads.

- C. Connect positive ohmmeter lead to hot lead (positive lead) of circuit
- D. Connect negative ohmmeter lead to ground
- E. If ohmmeter scale indicates only minor resistance, the circuit is good
- F. Disconnect negative ohmmeter lead from ground
- G. Disconnect positive ohmmeter lead from circuit lead
- H. Reconnect negative battery cable to negative terminal
- I. Check switches and grounds in the same manner
- J. Remove eye protection and protective clothing
- K. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

JOB SHEET #3 — INSTALL A SOLDERED TERMINAL

I. Equipment and materials

A. Soldering gun or iron

B. Rosin-core solder

(NOTE: Use only rosin-core solder on electrical terminals.)

C. Medium-grit sandpaper

D. Appropriate terminal

E. Electrical wire of appropriate gauge

(NOTE: Always use the same wire gauge as was used by the manufacturer.)

F. Electrical tape

G. Multipurpose electrician's pliers

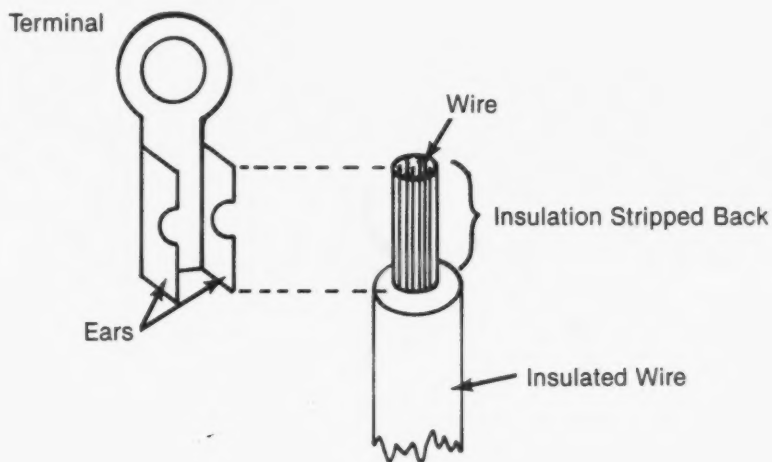
H. Eye protection

II. Procedure

A. Remove all jewelry and put on eye protection

B. Use multipurpose pliers to strip back insulation from end of wire to permit installation of terminal (Figure 8)

FIGURE 8



JOB SHEET #3

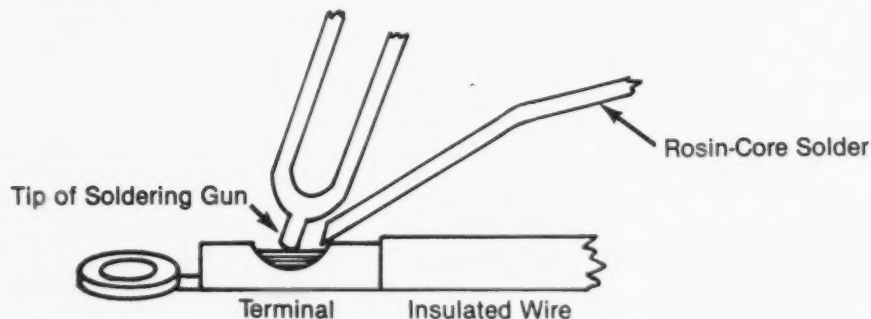
- C. Clean terminal with sandpaper
- D. Place wire in terminal, and use multipurpose pliers to bend ears of terminal around wire (Figure 9)

FIGURE 9



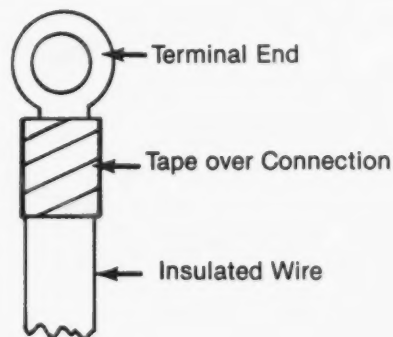
- E. Solder terminal to wire, applying only enough solder to attach terminal securely (Figure 10)

FIGURE 10



- F. Cover connection with electrical tape to insulate from other wires (Figure 11)

FIGURE 11



- G. Remove eye protection
- H. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

JOB SHEET #4 — INSTALL A SOLDERLESS TERMINAL

I. Equipment and materials

- A. Appropriate terminal
- B. Electrical wire of appropriate gauge

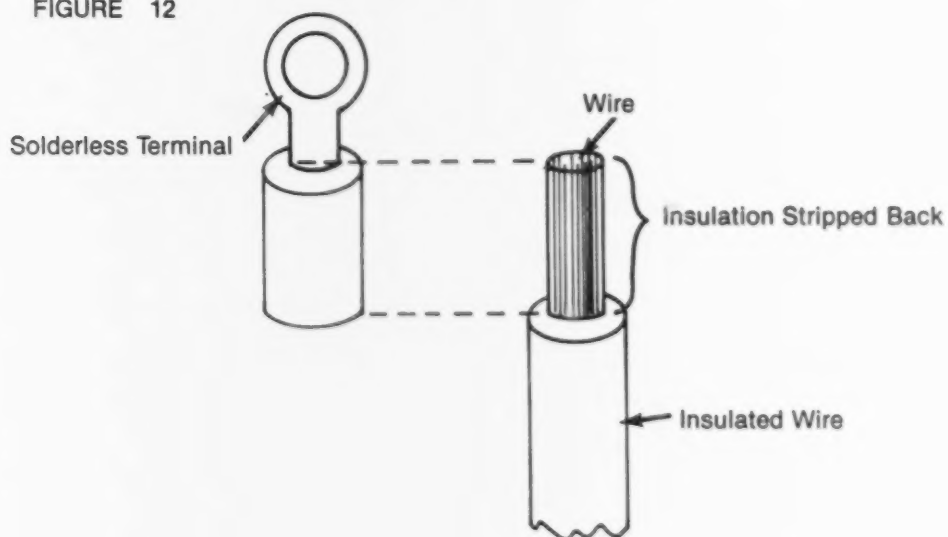
(NOTE: Always use the same wire gauge as was used by the manufacturer.)

- C. Multipurpose electrician's pliers
- D. Eye protection

II. Procedure

- A. Remove all jewelry and put on eye protection
- B. Use multipurpose pliers to strip back insulation from end of wire to permit installation of terminal (Figure 12)

FIGURE 12

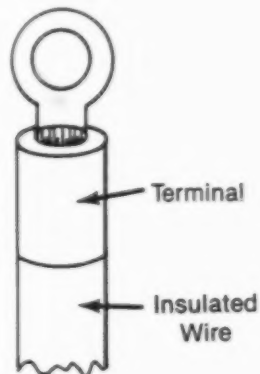


JOB SHEET #4

C. Insert wire into terminal (Figure 13)

(NOTE: Always use a terminal that fits the wire properly.)

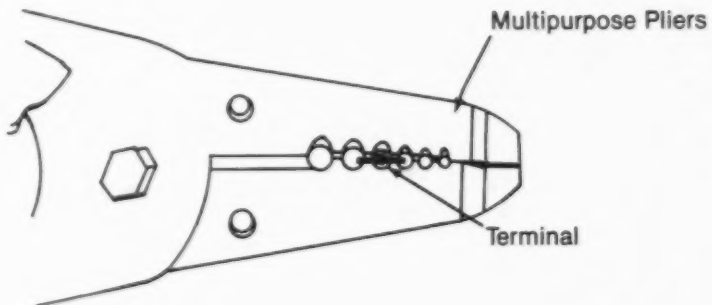
FIGURE 13



D. Use multipurpose pliers to crimp terminal to wire (Figure 14)

(NOTE: Use the correct crimper opening in the pliers to ensure a snug fit.)

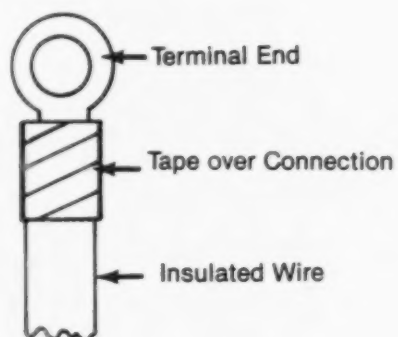
FIGURE 14



JOB SHEET #4

E. Cover connection with electrical tape to insulate from other wires (Figure 15)

FIGURE 15



F. Remove eye protection

G. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

JOB SHEET #5 — SOLDER-SPLICE A WIRE

I. Equipment and materials

A. Soldering gun or iron

B. Rosin-core solder

(NOTE: Use only rosin-core solder on electrical wires.)

C. Electrical wire

D. Electrical tape

E. Multipurpose electrician's pliers

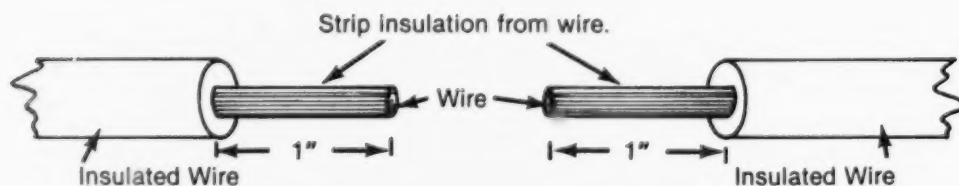
F. Eye protection

II. Procedure

A. Remove all jewelry and put on eye protection

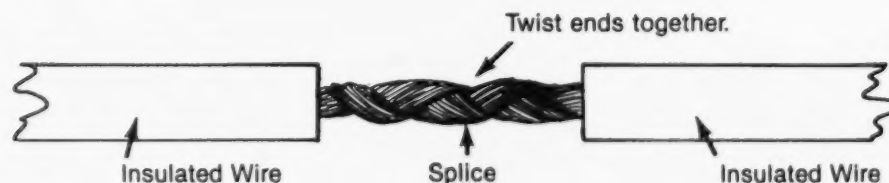
B. Use multipurpose pliers to strip back insulation 1 inch from end of wire (Figure 16)

FIGURE 16



C. Twist ends of wire together (Figure 17)

FIGURE 17



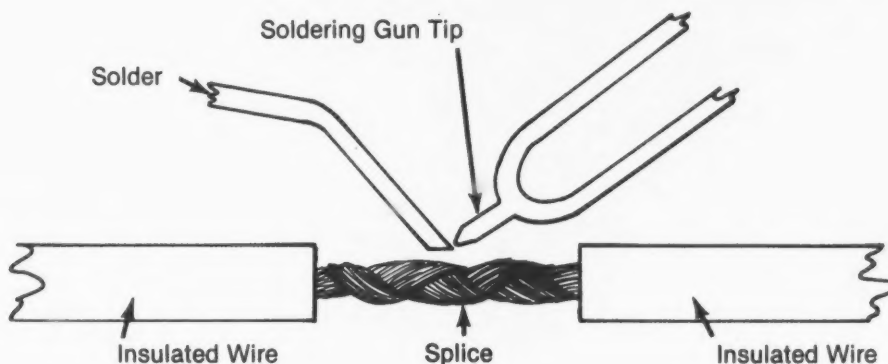
JOB SHEET #5

- D. Solder the wire ends together, applying only enough solder to hold wire securely (Figure 18)

CAUTION

Do not waste solder nor build up the joint. The splice joint will break if too much solder is applied.

FIGURE 18



- E. Wrap splice neatly with electrical tape to insulate from other wires (Figure 19)

FIGURE 19



- F. Remove eye protection
- G. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

JOB SHEET #6 — REMOVE, REPLACE, AND ALIGN SEALED-BEAM HEADLIGHTS

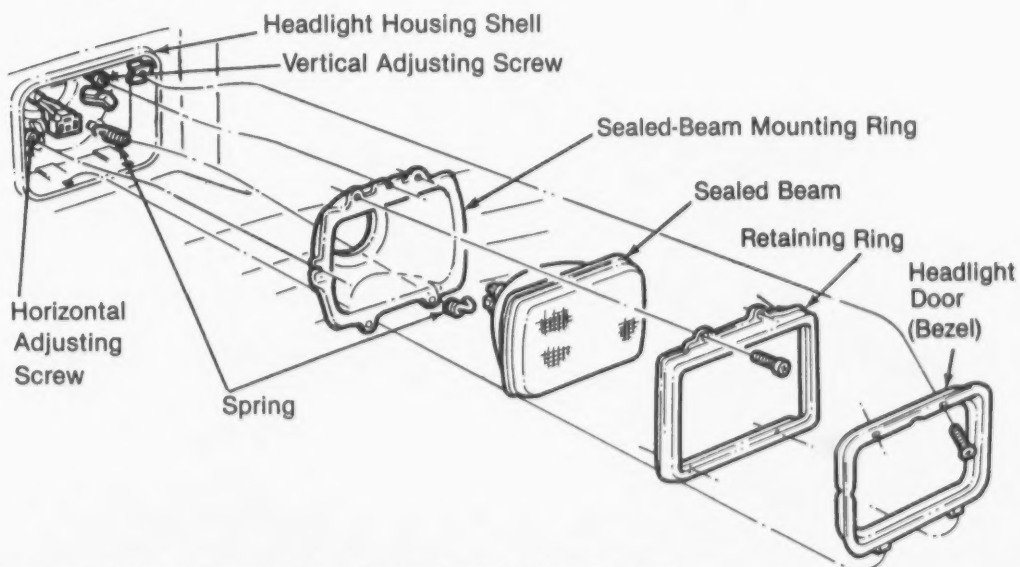
I. Equipment and materials

- A. Vehicle to be repaired
- B. Vehicle service manual
- C. Appropriate replacement sealed beam
- D. Mechanical almer (headlight aligner) and instruction manual
- E. Straight-blade screwdriver set
- F. Phillips screwdriver set
- G. Masking tape
- H. Eye protection

II. Procedure

- A. Put on eye protection
- B. Remove damaged or inoperable sealed beam (Figure 20)

FIGURE 20



Used with permission of Chevrolet Motor Division, General Motors Corporation.

JOB SHEET #6

1. Remove headlight door (bezel) retaining screws and remove door
2. Stick screws to a piece of masking tape, tape to door, and set door aside where it will not get stepped on or damaged
3. Disengage spring (if applicable) from retaining ring, remove attaching screws, and remove retaining ring
4. Stick screws to a piece of masking tape, tape to retaining ring, and set retaining ring aside where it will not get stepped on or damaged
5. Disconnect sealed beam unit at wiring connector and remove unit

C. Install replacement sealed beam

1. Attach appropriate connector and position beam according to manufacturer's specifications
2. Position retaining ring in place and install spring (if applicable) and retaining ring attaching screws

(NOTE: On some models, the spring from the headlight housing shell to the headlight mounting ring must be attached before the retaining ring attaching screws are installed. Follow instructions in the vehicle service manual and take care not to stretch the spring.)

D. Check operation of lamp

E. Reinstall headlight door (bezel)

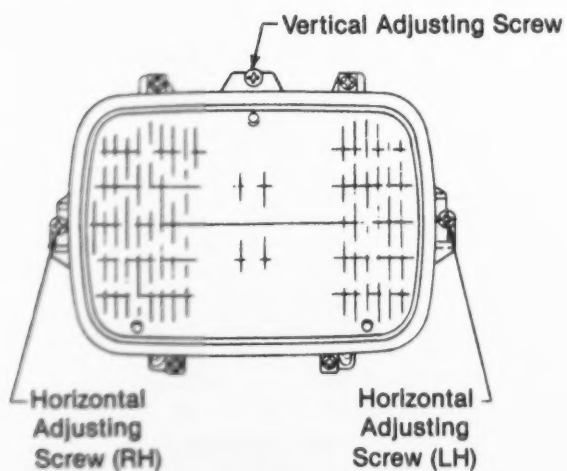
(NOTE: On some models, the headlights must be aligned before the headlight door is reinstalled. Check the vehicle service manual.)

F. Align headlights

1. Read instruction manual for mechanical aimer
2. Install or set up aimer according to manufacturer's directions
3. Adjust vertical adjusting screws until aimer indicates specified alignment (See Figure 21)
4. Adjust horizontal adjusting screws until aimer indicates specified alignment (See Figure 21)

JOB SHEET #6

FIGURE 21



Used with permission of General Motors Corporation.

G. Remove eye protection

H. Clean work area and return equipment and materials to proper storage

CIRCUITS AND WIRES
UNIT X

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with circuits and wires. Write the correct numbers in the blanks. Terms and definitions are continued on the next page.

- | | |
|---|-------------------------------|
| _____ a. Drawing that uses electrical symbols to show electrical circuits | 1. Insulator |
| _____ b. Stranded conductors, usually covered with insulating material | 2. Wiring diagram (schematic) |
| _____ c. Low-tension conductor used for low-voltage ignition, lighting, and accessory circuits | 3. Conductor |
| _____ d. Device used to attach electrical wires (conductors) to electrical components | 4. Cable |
| _____ e. Device—usually a glass tube with metal ends connected by a metal strip—designed to melt during an excessive amount of current flow | 5. Primary wire |
| _____ f. Circuit in which a wire is broken or disconnected and current is unable to flow | 6. Circuit |
| _____ g. Electric generator that produces alternating current | 7. Fuse |
| _____ h. Steady flow of electrons moving continually in the same direction along a conductor from a point of high potential to one of lower potential | 8. Load |
| _____ i. Any material that resists the flow of electrical current, preventing it from leaking (shorting) to another conductor | 9. Connector (terminal) |
| _____ j. Continuous path along a conductor through which electrical current can flow from a power source through a load and back to the source | 10. Open circuit |
| _____ k. Any material that allows electrical current to flow through it easily | 11. Alternator |
| _____ l. Object that converts electrical energy into heat, light, or mechanical energy | 12. Direct current (DC) |
| _____ m. Flow of electrons in a conductor that reverses direction of flow at intervals | 13. Alternating current (AC) |
| _____ n. Electric generator that produces direct current | 14. Generator |

TEST

- | | |
|---|---------------------------|
| _____o. Circuit in which wire touches ground, causing current to flow to ground instead of through circuit | 15. Junction block |
| _____p. Circuit in which a wire touches another wire and provides a shorter path for current flow | 16. Wiring harness |
| _____q. Mechanical device activated by heat; when amperage exceeds the device's safety rating, a set of contact points opens and stops current flow | 17. Condenser (capacitor) |
| _____r. Device that stores extra current to prevent arcing and burning as the contact points open | 18. Circuit breaker |
| _____s. Device designed to open and close a circuit | 19. Short circuit |
| _____t. High-tension conductor used for high-voltage ignition circuits, as in a spark plug or coil wires | 20. Grounded circuit |
| _____u. Multiple connection point for current or ground; may be used as a test point | 21. Switch |
| _____v. System of wires that are taped together and designed to supply power to all electrical devices throughout the vehicle | 22. Secondary wire |

2. Match common electrical symbols to their correct interpretations. Write the correct numbers in the blanks. Symbols and interpretations are continued on the next page.

- _____a. Old symbol for crossing conductors
- _____b. Old symbol for inductor
- _____c. Circuit breaker
- _____d. New symbol for crossing conductors
- _____e. New symbol for inductor
- _____f. Connection
- _____g. Terminal

4. 

5. 

1. 

6. 

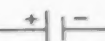
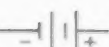
2. 

7. 

3. 

TEST

_____h. Conductor	_____r. Spark gap	_____aa. Incandescent lamp
_____i. Fixed resistor	_____s. Ammeter	_____bb. Fuse
_____j. Variable resistor (rheostat)	_____t. Voltmeter	_____cc. Alternator
_____k. Contact points	_____u. Generator	_____dd. Open switch
_____l. Ground	_____v. Alternating current motor	_____ee. Closed switch
_____m. Transistor (PNP)	_____w. Direct current motor	_____ff. Fusible link or wire
_____n. Transistor (NPN)	_____x. Solenoid	_____gg. Direction of current
_____o. Diode (one-way)	_____y. One-cell battery	_____hh. Iron-core inductor
_____p. Zener diode	_____z. Multicell battery	_____ii. Condenser (capacitor)
_____q. Indicator light		_____jj. Coil

8. 18. 28.  or 9. 19.  or  or 29. 10. 20.  or 30. 11. 21. 31. 12. 22. 32.  or 13.  or 23. 33. 14.  or 24. 34. 15. 25. 35. (A)  (K)16. 26. 36.  or  or 17. 27. 

TEST

3. List the basic components of a simple circuit.

- a. _____
 b. _____
 c. _____

4. Match current, voltage, and resistance to their correct units of measure. Write the correct numbers in the blanks.

- | | |
|--|---------------|
| _____ a. Flow of electrons measured in amperes | 1. Current |
| _____ b. Opposition to current flow measured in ohms | 2. Voltage |
| _____ c. Electrical pressure measured in volts | 3. Resistance |

5. List types of electrical test equipment.

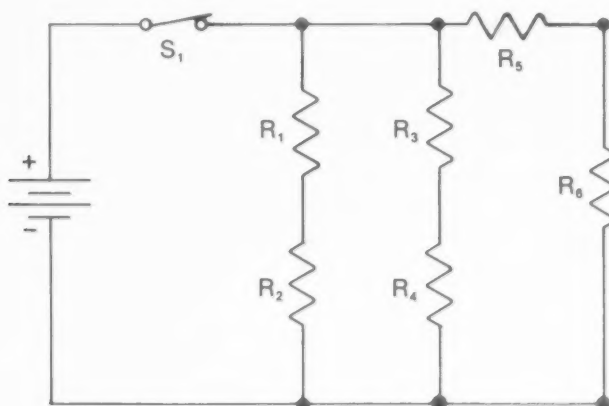
- a. _____
 b. _____
 c. _____
 d. _____

6. Identify the following types of circuits. Write the correct names in the blanks.

Series

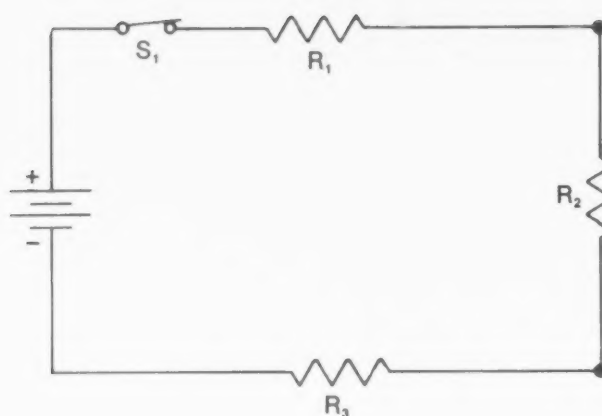
Parallel

Series parallel

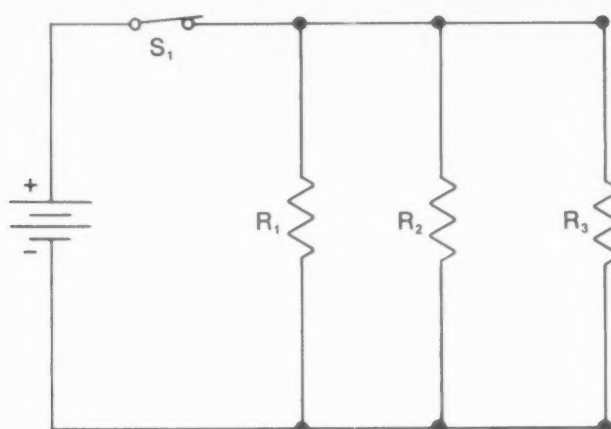


- a. _____

TEST



b. _____



c. _____

7. Arrange in order the steps for checking an electrical circuit from battery to ground. Write a "1" before the first step, a "2" before the second step, and so on.

- ____ a. Isolate problem
- ____ b. Identify color coding on wire from power source
- ____ c. Locate junction block, fuse panel, or breaker panel
- ____ d. Repair as necessary
- ____ e. Trace power supply wire from power source to component

TEST

8. Arrange in order the steps for troubleshooting an electrical system. Write a "1" before the first step, a "2" before the second step, and so on.

- _____a. Locate cause of problem
- _____b. Read wiring diagram or electrical schematic for circuit to be replaced
- _____c. Operate circuit to verify complaint
- _____d. Repair as necessary
- _____e. Recheck circuit to make sure that it is operating properly

9. List ten automotive electrical system safety rules.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____
- j. _____

10. Match types of wire connectors (terminals) to their correct names. Write the correct numbers in the blanks. Connectors and names are continued on the next page.

_____a. Ring (eyelet)



_____b. Roll



_____c. Female plug (bullet)

_____d. Male plug (bullet)



_____e. Female snap-on

_____f. Lug

TEST

- ____g. Female slide
- ____h. Male slide
- ____i. Insulated butt
- ____j. Three-way
- ____k. Slotted hook
- ____l. Slotted flange



11. Name types of wire splices.

- a. _____
- b. _____

12. Distinguish between single-filament and double-filament bulbs used in automotive lamp assemblies. Write a "1" before single-filament bulbs, and a "2" before double-filament bulbs.

- ____a. Taillight/stoplight/turn light lamp assembly
- ____b. High-beam, sealed-beam headlight
- ____c. Dome light
- ____d. Truck clearance light
- ____e. Low-beam/high-beam sealed-beam headlight
- ____f. Side marker lamp
- ____g. Instrument panel light

(NOTE: Test question 13 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

13. Demonstrate the ability to

- a. Check battery voltage.
- b. Check circuit continuity.
- c. Install a soldered terminal.
- d. Install a solderless terminal
- e. Solder-splice a wire.
- f. Remove, replace, and align sealed-beam headlights.

CIRCUITS AND WIRES
UNIT X

ANSWERS TO TEST

1. a. 2 l. 8
 b. 4 m. 13
 c. 5 n. 14
 d. 9 o. 20
 e. 7 p. 19
 f. 10 q. 18
 g. 11 r. 17
 h. 12 s. 21
 i. 1 t. 22
 j. 6 u. 15
 k. 3 v. 16
2. a. 3 m. 25 y. 33
 b. 5 n. 22 z. 27
 c. 1 o. 35 aa. 21
 d. 7 p. 36 bb. 20
 e. 4 q. 29 cc. 16
 f. 6 r. 24 dd. 34
 g. 2 s. 26 ee. 8
 h. 30 t. 17 ff. 18
 i. 14 u. 15 gg. 10
 j. 28 v. 12 hh. 31
 k. 13 w. 11 ii. 23
 l. 9 x. 19 jj. 32
3. a. Power source
 b. Load (resistor)
 c. Conductor
4. a. 1
 b. 3
 c. 2
5. a. Test lamp
 b. Ammeter
 c. Voltmeter
 d. Ohmmeter
6. a. Series parallel
 b. Series
 c. Parallel

ANSWERS TO TEST

7. a. 4
b. 2
c. 1
d. 5
e. 3
8. a. 3
b. 2
c. 1
d. 4
e. 5
9. Answer should include any ten of the following
- a. Remove all jewelry before disconnecting battery cables or working on any electrical circuit
 - b. Always remove ground (negative) cable first when disconnecting battery cables
 - c. Always disconnect battery cables before using ohmmeter
 - d. Never leave ignition switch on when installing a distributor
 - e. Never ground output terminal of an alternator
 - f. Never lay a conductor across battery terminals
 - g. Always disconnect battery before replacing an electrical component
 - h. Never apply full battery voltage to a fuel tank sending unit
 - i. When using jumper cables, always connect ground to frame or engine
 - j. When using battery charger, disconnect battery cables and connect charger to battery before plugging charger into power supply
 - k. Before installing an electrical accessory, make sure that the ground matches that of vehicle polarity
 - l. When adding accessories, be sure not to exceed charging system output
 - m. Always replace worn or damaged conductors (wires) with conductors of the same gauge as those being replaced
10. a. 10 g. 1
b. 5 h. 11
c. 12 i. 7
d. 8 j. 6
e. 3 k. 9
f. 4 l. 2
11. a. Solder splice
b. Solderless splice
12. a. 2 e. 2
b. 1 f. 1
c. 1 g. 1
d. 1
13. Performance skills evaluated to the satisfaction of the instructor

BATTERY SERVICE
UNIT XI

UNIT OBJECTIVE

After completing this unit, the student should be able to practice safety and use the correct tools to service a battery. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with batteries.
2. Label the parts of a battery.
3. Match to their correct definitions terms associated with battery testing.
4. List battery service safety rules.
5. Label battery service specialty tools.
6. Demonstrate the ability to
 - a. Remove, clean, and reinstall a battery.
 - b. Check a battery with a hydrometer.
 - c. Charge a battery.
 - d. Load-test a battery.
 - e. Charge-test a battery for three minutes.

BATTERY SERVICE
UNIT XI

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Supplements
 - 1. Supplement #1 — Battery Fact Sheet
 - 2. Supplement #2 — First Aid for Electrolyte Contact with Eyes or Skin
 - D. Transparency master: TM #1 — Current and Electrolyte
 - E. Information sheet
 - F. Assignment Sheet #1 — Complete Battery Service Safety Rules
 - G. Answers to assignment sheet
 - H. Job sheets
 - 1. Job Sheet #1 — Remove, Clean, and Reinstall a Battery
 - 2. Job Sheet #2 — Check a Battery with a Hydrometer
 - 3. Job Sheet #3 — Charge a Battery
 - 4. Job Sheet #4 — Load-Test a Battery
 - 5. Job Sheet #5 — Charge-Test a Battery for Three Minutes
 - I. Test
 - J. Answers to test
- II. Instructor's guide
 - A. Review unit and plan presentation.
 - B. Order or obtain materials to supplement unit.
 - 1. Battery group size charts and other literature from local battery distributor
 - 2. Live side-terminal and top-terminal batteries

SUGGESTED ACTIVITIES

3. Variety of battery and circuit testers
4. Distilled water, sugar solution, salt solution so that students may test specific gravity of each
5. Voltmeter
6. Jumper cables
7. Samples of specialty tools illustrated in Information Sheet, Section V
8. Litmus paper
9. Competency profiles

(NOTE: Competency profiles are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Explain that the battery is the heart of the automobile's electrical system.
- Explain that even though a 12-volt automobile battery does not have high voltage, it does have the necessary amperage for welding.
- Explain that the electrical current in batteries has been the culprit in several automobile fires.
- Stress that auto-body technicians need to be aware of the potential hazards posed by batteries and must observe safety precautions to protect themselves and others in the shop.

E. Discuss unit and specific objectives.

F. Discuss information and assignment sheets.

1. Use Information Sheet, Section I to discuss battery-related terms and definitions.

SUGGESTION:

- Explain that battery terminology is essential for understanding and correctly servicing batteries.

SUGGESTED ACTIVITIES

2. Use Information Sheet, Section II to illustrate and explain the parts of top-terminal and side-terminal batteries.

SUGGESTION:

- Use two live models for demonstration purposes, one with top terminals and one with side terminals. Point out the differences, stressing the differences in size and color of the terminals.
3. Use Information Sheet, Section III to discuss terms associated with battery testing.

SUGGESTIONS:

- Let students examine samples of different battery and circuit testers.
- Demonstrate how to use the different battery and circuit testers.
- Explain how specific gravity affects battery readings. Use Transparency #1 to illustrate your explanation.

EXAMPLE: Electrolyte is a mixture of sulfuric acid and water. Sulfuric acid weighs more than plain water; therefore, a given volume of electrolyte solution weighs more than an equal volume of plain water. The weight (gravity) of the electrolyte tells the charge state of the battery. As a battery discharges, the dissolved sulfuric acid leaves the electrolyte solution and chemically becomes part of the plates. As the acid leaves the solution, the weight (specific gravity) becomes less. If a battery is charged, the process is reversed; therefore, a low gravity reading indicates a low charge, while a high gravity reading indicates a high charge.

- Let students measure the specific gravity of distilled water, a sugar solution, and a salt solution.
 - Let students measure with a voltmeter the voltage of a wet-cell battery and a dry-cell battery.
4. Use Information Sheet, Section IV to discuss battery service safety rules.

SUGGESTIONS:

- Provide students with Supplements #1 and #2. Read and discuss with class.
- Prepare a visual aid to show students what happens to clothing that has come in contact with battery acid.

SUGGESTED ACTIVITIES

- Use a treated red shop towel or litmus paper to show the presence of acid on what appears to be a clean battery top.
 - Demonstrate correct procedure for using jumper cables, stressing correct polarity.
 - Have students complete Assignment Sheet #1.
5. Use Information Sheet, Section V to discuss battery service specialty tools.

SUGGESTIONS:

- Have students examine samples of each specialty tool.
 - Point out the importance of cleaning tools after use to prevent corrosion.
- G. Demonstrate each of the job sheets, pointing out potential hazards and stressing safety.
- H. Assign job sheets and set deadlines for completion.
- I. Give test.
- J. Critique test and discuss in class.
- K. Reteach and retest if necessary.
- L. Complete appropriate section of competency profiles.
- III. Unit references
- A. Billet, Walter E., and Leslie F. Goings. *Automotive Electrical Systems*, 3rd ed. Chicago, Illinois: American Technical Society, 1970.
- B. Crouse, William H. *Automotive Mechanics*. New York: Webster Division, McGraw-Hill Book Co., 1965.
- C. "Fact Sheet No. 82: Batteries." Washington, D.C.: U.S. Consumer Product Safety Commission, 1977.
- D. *Fundamentals of Service: Electrical Systems Manual*. Moline, Illinois: Deere and Company, 1968.
- E. Lyons, Kathleen. *Engine Tune Up Service: Student Guide*, 2nd ed. Tallahassee, Florida: Department of Education, July, 1981.
- F. *Tractor Maintenance: Principals and Procedures*. American Association for Vocational Instructional Materials, n.d.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — BATTERY FACT SHEET

FACT SHEET

U.S. CONSUMER PRODUCT SAFETY COMMISSION WASHINGTON, D.C. 20207

NO.82: BATTERIES

The U.S. Consumer Product Safety Commission estimates that more than 10,000 persons receive hospital emergency room treatment each year for injuries associated with wet-cell batteries and dry-cell batteries. The typical injury is a chemical burn caused by contact with acid in the battery.

WET-CELL BATTERIES

The most common storage battery is found in the automobile. Car batteries contain a solution of sulfuric acid and water that, when activated, produces explosive gases which are easily ignited.

The explosive gases and the acid can contribute to severe injury, as illustrated in the following cases taken from CPSC investigation files:

SANDRA WAS ATTEMPTING TO JUMP START HER CAR. AS SHE WAS CONNECTING THE CABLES TO THE DEAD BATTERY, A SPARK WAS PRODUCED WHICH CAUSED THE BATTERY TO EXPLODE. THE BATTERY CAPS FLEW OFF AND BATTERY ACID SPLASHED INTO HER EYES, CAUSING CHEMICAL BURNS.

HENRY WAS TRYING TO JUMP START HIS FRIEND'S CAR. WHEN CONNECTING THE JUMPER CABLES, HE UNKNOWINGLY CROSSED THE POLARITY BY CONNECTING ONE CABLE TO THE POSITIVE TERMINAL ON HIS BATTERY AND THE OTHER END TO THE NEGATIVE TERMINAL ON THE DEAD BATTERY. AS HE CONNECTED THE OTHER CABLE, NEGATIVE TO POSITIVE, HIS BATTERY EXPLODED. HE CUT HIS HAND AND SUFFERED A CHEMICAL BURN TO HIS EYE FROM THE BATTERY ACID.

JOHN TOOK THE CAPS OFF HIS BATTERY TO CHECK THE WATER LEVEL. HE LIT A CIGARETTE LIGHTER FOR MORE LIGHT AND AS HE HELD THE LIGHTER NEAR THE HOLES, THE GASES FROM THE BATTERY IGNITED, CAUSING AN EXPLOSION WHICH SPLASHED BATTERY ACID INTO HIS EYES.

KELLY WAS CLEANING THE ACCUMULATED CORROSION FROM THE TERMINALS ON HER CAR BATTERY WITH A SODA SOLUTION AND A CLEANING CLOTH. AFTER SHE FINISHED, SHE INADVERTENTLY RUBBED ONE EYE BEFORE WASHING HER HANDS. THE ACID IN THE CORROSION CAUSED A CHEMICAL BURN IN HER EYE.

These case histories illustrate major accident patterns associated with wet-cell batteries. Most accidents occur when batteries are jumped, recharged, or otherwise serviced.

To report a product hazard or a product-related injury, write to the U.S. Consumer Product Safety Commission, Washington, D.C. 20207. In the continental United States, call the toll-free safety hot line 800-638-2666. Maryland residents only, call 800-492-2937.

SUGGESTED ACTIVITIES

SUPPLEMENT #2 — FIRST AID FOR ELECTROLYTE CONTACT WITH EYES OR SKIN

Eye Contact

1. Immediately flush with water for at least fifteen minutes
2. Seek medical attention immediately
3. If medical assistance is not available, neutralize acid with baking soda and water solution (2 tablespoons baking soda in 2 cups of water)



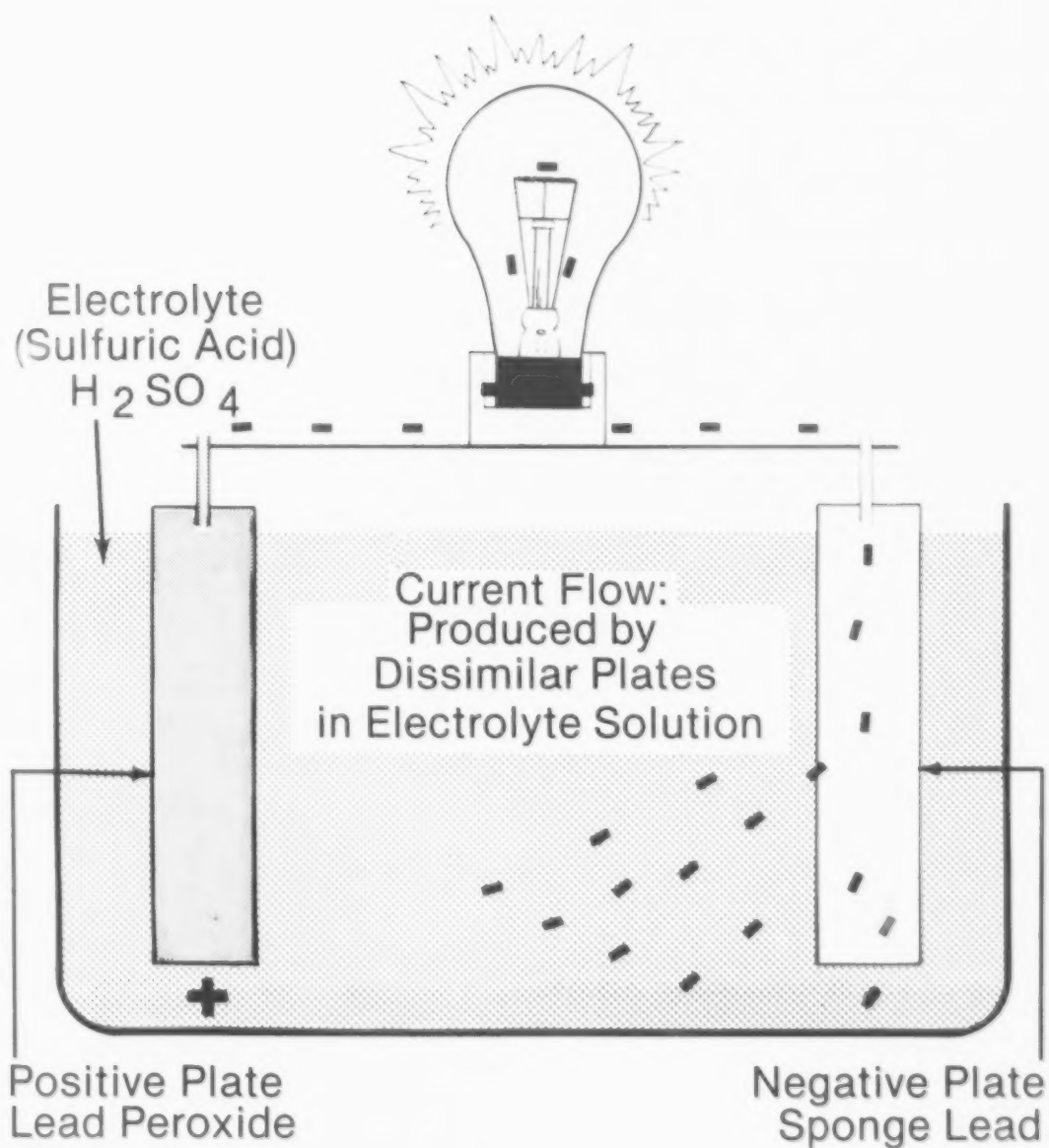
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Department of Education.

Skin Contact

1. Remove clothing from affected area
2. Wash area with plenty of soap and water for at least five minutes
3. Seek medical attention if blistering, burning, or peeling occurs

Current and Electrolyte

How a Battery Converts Chemical Energy
into Electrical Energy



BATTERY SERVICE UNIT XI

INFORMATION SHEET

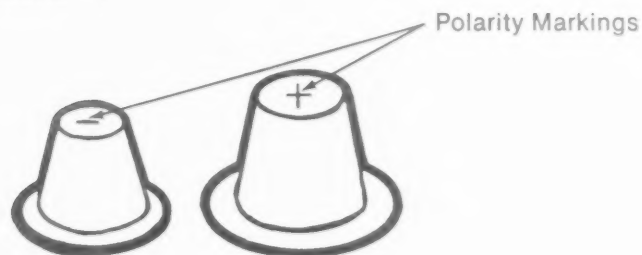
I. Terms and definitions

- A. Battery — Source of electric current for vehicle and power source for cranking system
- B. Terminal — Post made of lead that carries electrical charge between battery cells and battery cable

(NOTE: A battery contains two terminals, one positive [+] and one negative [-]. The terminals may be located either on the top or the side of the battery. On a side-terminal battery, the bolt and thread sizes of the positive terminal are larger than those of the negative terminal. On a top-terminal battery, the positive terminal post is larger than the negative terminal post. See Figure 1.)

EXAMPLE: Top-terminal posts

FIGURE 1



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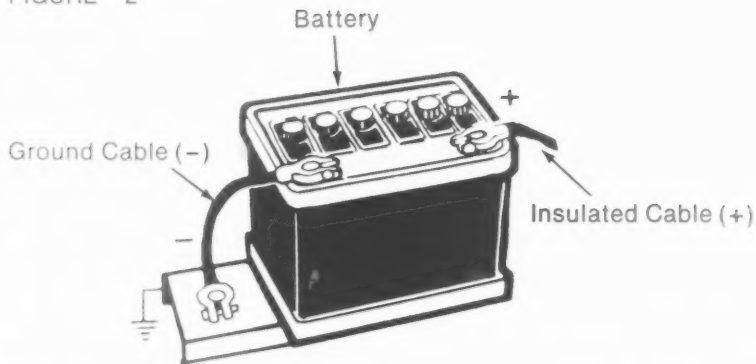
- C. Amperage — Strength of current flowing through a circuit at one time
- D. Circuit — Complete path that electricity follows; consists of battery, wiring, electrical devices, and vehicle frame and metal body
- E. Ground — Any electrical part connected to vehicle frame or engine block

(NOTE: The negative battery terminal is usually grounded. See Figure 2.)

INFORMATION SHEET

EXAMPLE:

FIGURE 2



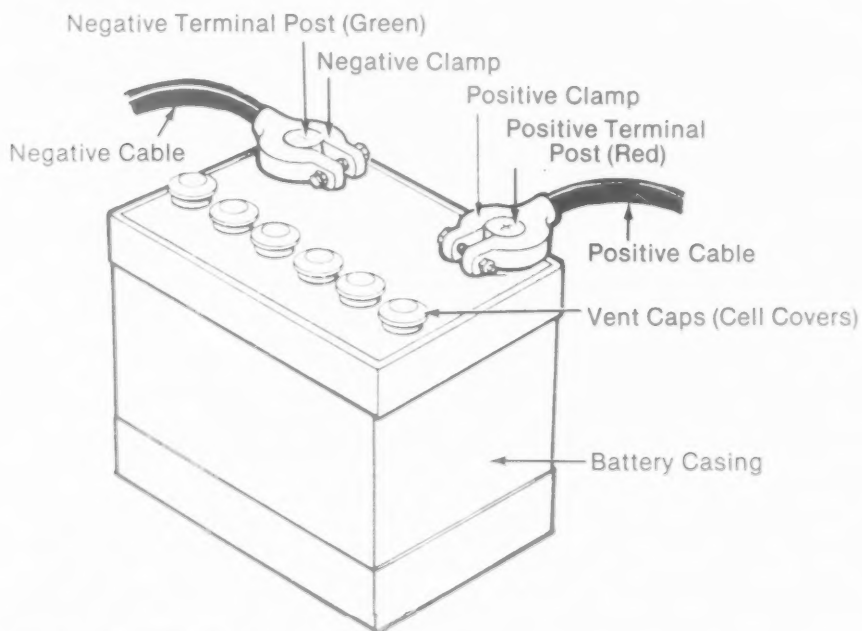
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F. Voltage — Amount of pressure that pushes or forces current in circuit

II. Parts of a battery (Figures 3 and 4)

A. Top-terminal battery

FIGURE 3

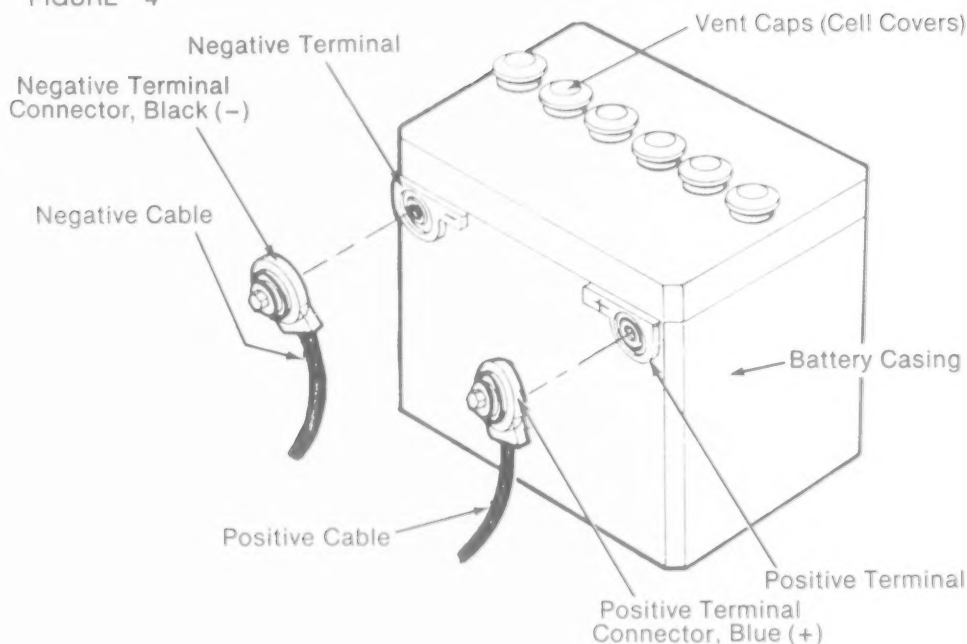


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INFORMATION SHEET

B. Side-terminal battery

FIGURE 4



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III. Terms associated with battery testing

- A. Specific gravity — Weight of solution compared to distilled water reading 1.000
- B. Battery hydrometer — Instrument used to measure specific gravity (weight) of battery electrolyte (solution) to determine strength of charge
- C. Electrolyte — Solution of sulfuric acid (H_2SO_4) and water (H_2O) used in automotive wet-cell batteries
- D. Voltmeter — Instrument used to measure voltage between two points in an electrical circuit
- E. Ammeter — Instrument used to measure amount of current in an electrical circuit
- F. Battery, starter, charging system tester — Combination ammeter and voltmeter with a carbon pile control used to test more than one electrical circuit

(NOTE: The carbon pile control introduces resistance in an electrical circuit to simulate electrical loads.)

INFORMATION SHEET

- G. Test light — Simple device used to check the presence of electrical current in a circuit

(NOTE: For continuity testing, the automotive trades commonly use a metal probe with attached light bulb and test lead.)

IV. Battery service safety rules

- A. Do not allow battery electrolyte to spill or to come in contact with clothing, skin, eyes, or painted surfaces of vehicle
- B. Wear appropriate eye protection, rubber gloves, and rubber apron at all times when servicing batteries
- C. Use fender covers to protect vehicle finish
- D. Remove all jewelry before servicing battery
- E. Keep sparks and flames away from battery at all times; gases (hydrogen and oxygen) given off by a battery are very explosive
- F. Never short or ground battery during servicing as this may cause battery to explode
- G. Always disconnect negative cable *first* to prevent arcing in the terminal and possible explosion
- H. Always reconnect negative cable *last* to prevent arcing in the terminal and possible explosion
- I. Always observe polarity when connecting and disconnecting cables
- J. If battery begins to bulge, spurt, or react violently during charging, stop charging and stand clear

(NOTE: A slower charging rate may correct the problem. The electrolyte temperature should never exceed 125°F during charging.)

- K. Never charge or jump start a frozen battery
- L. Never fast charge a maintenance-free (sealed) battery
- M. Always turn off charger *before* connecting to or disconnecting from battery
- N. Never charge a battery in a closed, unventilated room
- O. Avoid breathing fumes from battery that is being charged

INFORMATION SHEET

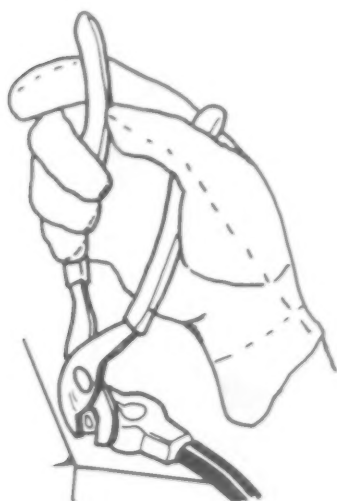
- P. When using jumper cables, connect the negative ground cable to the frame, engine bracket, or other suitable ground, *never* to the battery terminal

(NOTE: If the negative cable is properly grounded and arcing should occur, the spark will not be close to the battery.)

V. Battery service specialty tools (Figures 5-11)

A. Battery pliers

FIGURE 5



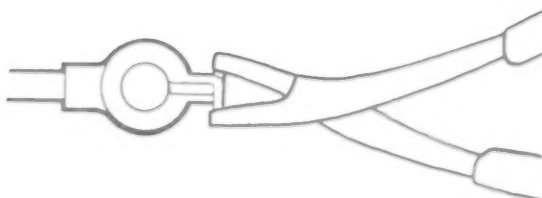
B. Battery clamp spreader

FIGURE 6



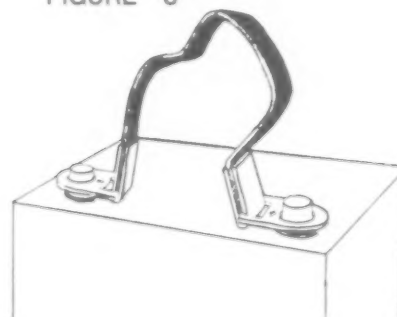
C. G.M. spring-cable pliers

FIGURE 7



D. Carrying strap

FIGURE 8



Figures 5 through 8 used with permission of the State of Florida, Department of Education.

INFORMATION SHEET

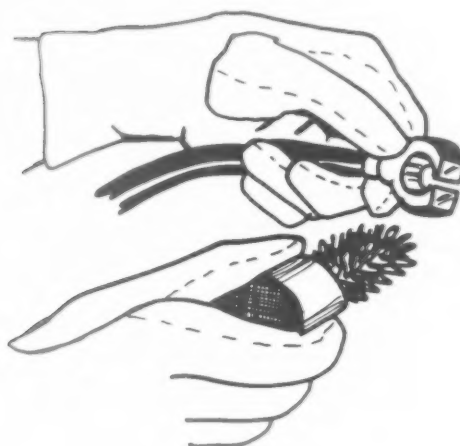
E. Clamp puller

FIGURE 9



F. Wire brush

FIGURE 10



G. Terminal cleaner

FIGURE 11



Figures 9 through 11 used with permission of the State of Florida, Department of Education.

BATTERY SERVICE
UNIT XI

ASSIGNMENT SHEET #1 — COMPLETE BATTERY SERVICE SAFETY RULES

NAME _____ SCORE _____

The acid solution, explosive gases, and electricity in an automotive battery present potential hazards to the auto-body technician. Therefore, it is very important that the technician observe and understand battery service safety rules.

Treat this assignment sheet as though it were a self-test, and do not refer to the information sheet to help you complete the following battery service safety rules. When you have completed the assignment sheet by writing the correct word or words in the blanks, exchange your assignment sheet with a class member's assignment sheet and grade it. Refer to Information Sheet, Section IV for correct answers, and count each blank—regardless of the number of words it contains—as 4 points. Perfect score is 100 points.

- A. Do not allow battery electrolyte to spill or to come in contact with _____ , _____ , _____ , or _____ of vehicle
- B. Wear appropriate _____ protection, _____ at all times when servicing batteries
- C. Use _____ to protect vehicle finish
- D. Remove all _____ when servicing battery
- E. Keep _____ and _____ away from battery at all times; gases (hydrogen and oxygen) given off by battery are very explosive
- F. Never _____ or _____ battery during servicing as this may cause battery to explode
- G. Always disconnect negative cable _____ to prevent arcing in the terminal and possible explosion
- H. Always reconnect negative cable _____ to prevent arcing in the terminal and possible explosion

ASSIGNMENT SHEET #1

- I. Always observe _____ when connecting or disconnecting cables
- J. If battery begins to bulge, spurt, or react violently during charging,

- K. Never charge or jump start a _____ battery
- L. Never _____ a maintenance-free (sealed) battery
- M. Always turn off _____ *before* connecting to or disconnecting from battery
- N. Never charge a battery in a closed, _____ room
- O. Avoid _____ fumes from battery that is being charged
- P. When using jumper cables, connect the _____ ground cable to the frame, engine bracket, or other suitable ground, *never* to the _____

BATTERY SERVICE
UNIT XI

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

- A. Clothing, skin, eyes, painted surfaces
- B. Eye, rubber gloves and rubber apron
- C. Fender covers
- D. Jewelry
- E. Sparks, flames
- F. Short, ground
- G. First
- H. Last
- I. Polarity
- J. Stop charging and stand clear
- K. Frozen
- L. Fast charge
- M. Charger
- N. Unventilated
- O. Breathing
- P. Negative, battery terminal

BATTERY SERVICE
UNIT XI

JOB SHEET #1 — REMOVE, CLEAN, AND REINSTALL A BATTERY

I. Equipment and materials

- A. Vehicle with side-terminal or top-terminal battery
- B. Bristle brush
- C. Wire brush
- D. Terminal cleaning tool
- E. Screwdriver
- F. Pliers
- G. Battery clamp puller
- H. Battery lift strap
- I. Combination-end wrenches, $\frac{7}{16}$ ", $\frac{1}{2}$ ", and $\frac{9}{16}$ "
- J. Replacement battery cable
- K. Battery cable spreader
- L. Baking soda
- M. Clean water
- N. Container for baking soda and water solution
- O. Tablespoon
- P. Battery anticorrosion paste or spray
- Q. Fender covers
- R. Eye protection
- S. Rubber gloves
- T. Rubber apron

II. Procedure

- A. Put on eye protection, rubber gloves, and rubber apron

JOB SHEET #1

B. Place fender covers over vehicle fenders

C. Disconnect battery cables

1. Top-terminal battery

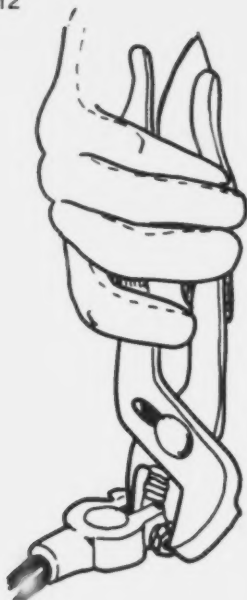
- a. Loosen nuts and bolts on battery cable clamps with a wrench
- b. Disconnect negative (grounded) battery cable from battery post

CAUTION

Always disconnect negative (grounded) battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.

- 1) Spread cable clamp with pliers (Figure 12)

FIGURE 12

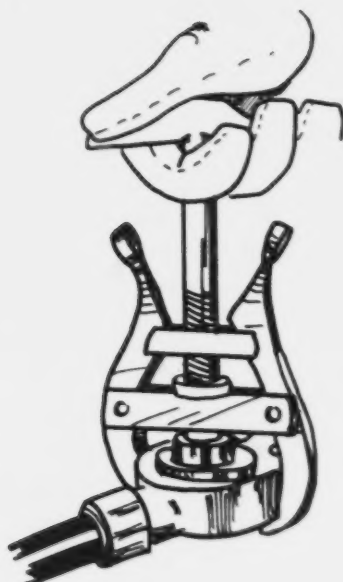


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- 2) Pull cable off with battery clamp puller (See Figure 13.)

JOB SHEET #1

FIGURE 13



c. Disconnect positive (power) battery cable from battery post in same manner

2. Side-terminal battery

a. Unscrew bolt from negative (grounded) terminal

CAUTION

Always disconnect negative (grounded) battery cable first to avoid short circuits.

b. Unscrew bolt from positive power terminal

D. Remove battery hold-down clamp or strap

E. Remove battery from vehicle, using a suitable battery lift strap to lift battery from battery tray

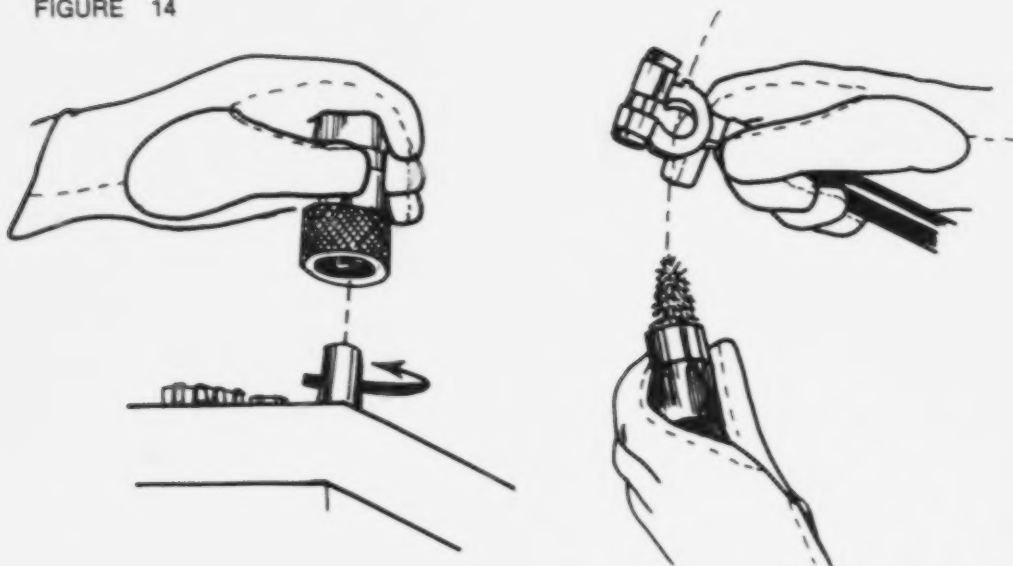
F. Inspect battery tray for dirt or corrosion; clean with baking soda and water solution (2 tablespoons baking soda to 2 cups [1 pint] water) if required

G. Check battery cables for worn or frayed insulation; replace as necessary

H. Use wire brush and terminal cleaner to clean battery cable clamps and posts on top-terminal battery (See Figure 14.)

JOB SHEET #1

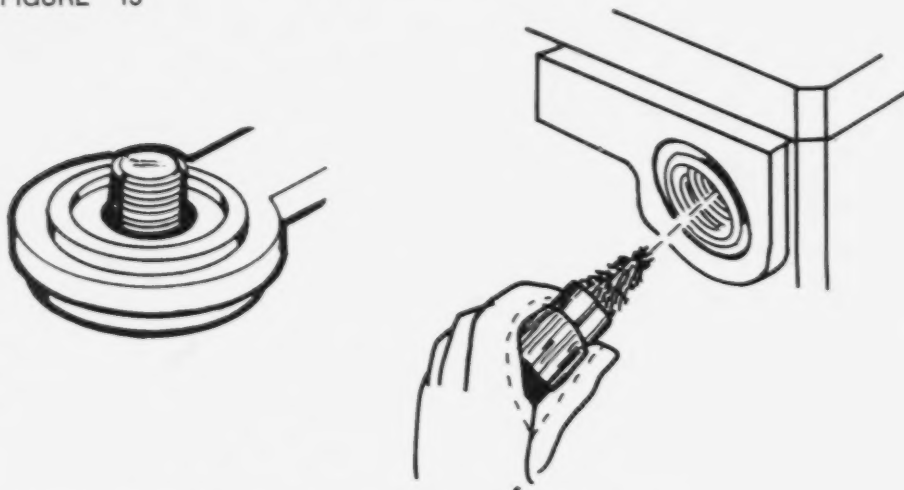
FIGURE 14



Used with permission of the State of Florida, Department of Education.

- I. Use wire brush to clean bolts, both sides of terminal connector, and contact area on side-terminal battery (Figure 15)

FIGURE 15

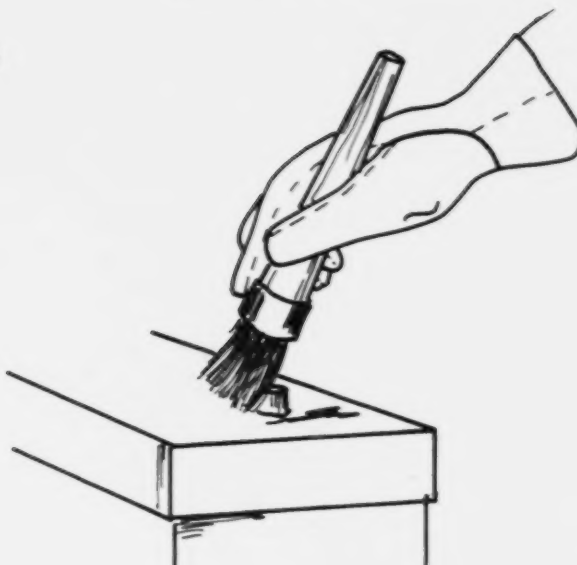


Adapted with permission of the State of Florida, Department of Education.

- J. Use bristle brush to remove loose dirt and corrosion particles from top of battery (See Figure 16.)

JOB SHEET #1

FIGURE 16



- K. Make a soda/water solution of 2 tablespoons baking soda to 2 cups (1 pint) of water
 - L. Brush soda/water solution on battery, battery posts and clamps (or bolts and terminal connectors), and battery hold-down clamp or strap (Figure 17)
- (NOTE: Be sure to prevent water and soda from entering the battery through the vent holes in the vent caps.)

FIGURE 17



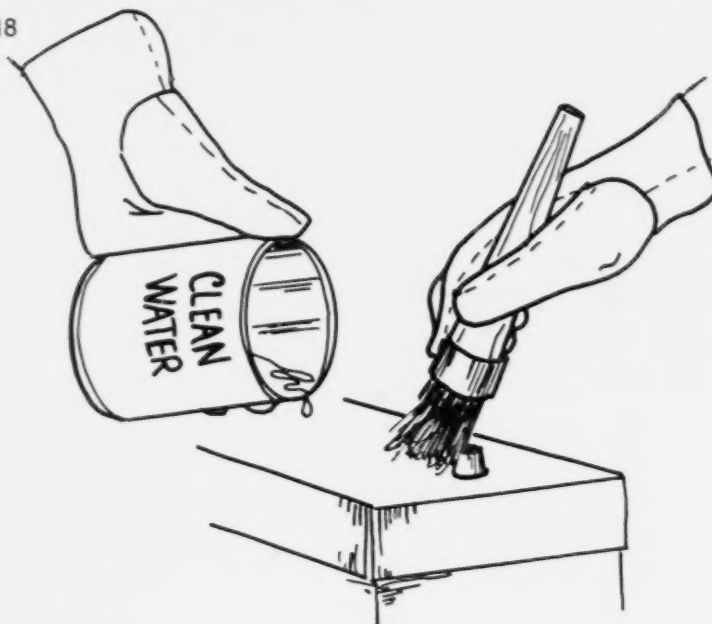
JOB SHEET #1

- M. Wash away residue with clean water, removing all residue that may have lodged around battery, frame, or other parts of vehicle (Figure 18)

CAUTION

Battery acid will damage the car finish. Do not allow it to contact the finish surface.

FIGURE 18



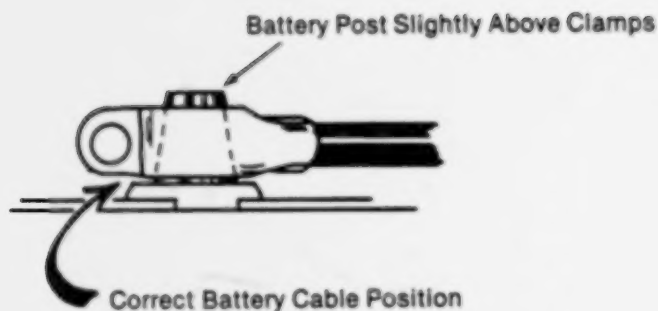
- N. Let battery dry naturally, or dry battery with paper towels and then discard towels
- O. Set battery into place, using lift strap and positioning battery to allow for correct cable attachment
- P. Reinstall battery hold-down clamp or strap and tighten securely
- Q. Reconnect positive (power) battery cable to battery post or terminal (See Figure 19.)

CAUTION

Always reconnect the power cable first and the ground cable last, and never use a hammer to install a battery cable as pounding could create dangerous sparks.

JOB SHEET #1

FIGURE 19



- R. Remove vent caps and check electrolyte level in all cells
- S. Add water if necessary to bring electrolyte to proper level

CAUTION

Add water *slowly*. Too much water will cause the electrolyte to spill out and corrode the battery case.

- T. Remove eye protection, protective clothing, and vehicle fender covers
- U. Clean work area and put away equipment and materials

BATTERY SERVICE
UNIT XI

JOB SHEET #2 — CHECK A BATTERY WITH A HYDROMETER

I. Equipment and materials

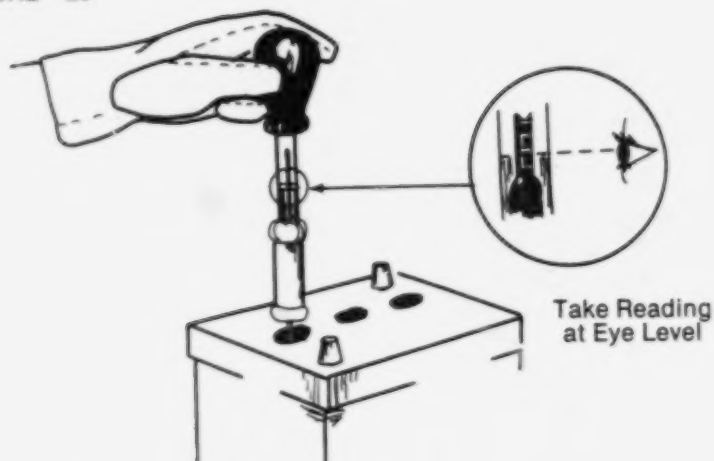
- A. Battery
- B. Hydrometer
- C. Shop towels
- D. Water container
- E. Eye protection
- F. Rubber apron
- G. Rubber gloves
- H. Pencil and paper
- I. Fender covers

II. Procedure

- A. Put on eye protection, rubber gloves, and rubber apron
- B. If battery is in vehicle, place fender covers over vehicle fenders
- C. Remove vent caps from battery
- D. Squeeze bulb on hydrometer
- E. Insert hydrometer into first cell
- F. Release rubber bulb to draw enough electrolyte into hydrometer to suspend the float; do not lift hydrometer out of electrolyte
- G. Check to be sure that hydrometer tube is vertical and that float is not bumping top of hydrometer tube or sticking to side of tube
- H. Take reading at eye level and record (See Figure 20.)

JOB SHEET #2

FIGURE 20



- I. Squeeze bulb to return electrolyte to cell
- J. Repeat process, taking and recording readings for each cell
- K. Adjust readings for temperature
 1. Add four gravity points (0.004) to the reading for each 10 degrees above 80°F
 2. Subtract four gravity points (0.004) from the reading for each 10 degrees below 80°F

(NOTE: Specific gravity should read from 1.215 to 1.270, corrected for 80°F electrolyte temperature. The variation in the readings between cells should be no more than 0.050. If the readings are not within this range, further testing will be required. See Table 1.)

TABLE 1

Specific gravity	Charge state
1.280	100%
1.250	75%
1.220	50% } Needs to be recharged
1.190	25% }
1.160	Not much useful charge
1.130	Discharged

JOB SHEET #2

- L. Replace vent caps
- M. Remove eye protection, protective clothing, and vehicle fender covers
- N. Clean work area and put away equipment and materials

BATTERY SERVICE
UNIT XI

JOB SHEET #3 — CHARGE A BATTERY

- I. Equipment and materials
 - A. Vehicle with 12-volt top-terminal or side-terminal battery
 - B. Vehicle service manual
 - C. Battery charger
 - D. Battery capacity tester or voltmeter
 - E. Battery service manual
 - F. Bristle brush
 - G. Wire brush
 - H. Terminal cleaning tool
 - I. Pliers
 - J. Screwdriver
 - K. Battery clamp puller
 - L. Combination-end wrenches, $\frac{7}{16}$ ", $\frac{1}{2}$ ", and $\frac{9}{16}$ "
 - M. Baking soda
 - N. Clean water
 - O. Container for baking soda and water solution
 - P. Tablespoon
 - Q. Fahrenheit thermometer
 - R. Hydrometer
 - S. Battery anticorrosion paste or spray
 - T. Fender covers
 - U. Shop towels
 - V. Eye protection
 - W. Rubber gloves
 - X. Rubber apron

JOB SHEET #3

II. Procedure

- A. Put on eye protection, rubber gloves, and rubber apron
- B. Place fender covers over vehicle fenders
- C. Check battery with hydrometer (Job Sheet #2)
- D. Clean and service battery (Job Sheet #1)
- E. Recheck battery with hydrometer, adjust readings for temperature, and record
- F. Check alternator belts according to manufacturer's specifications
- G. Charge battery
 1. Connect red (positive) charger cable to positive battery post or terminal; twist clamps to ensure a good connection
 2. Connect black (negative) charger cable to negative battery post or terminal; twist clamps to ensure a good connection

CAUTION

Always observe polarity and be sure to hook up the cables properly. Connecting a battery backward—negative to positive or positive to negative—could result in an explosion.

3. Set charger timer and charge rate control to OFF positions
4. Set charger selector for 12 volts
5. Plug AC cord into power source
6. Set charger timer to correct number of minutes (Table 2)

TABLE 2

Charging time		
Charge state	Specific gravity	Time
Low charge	1.150 or less	45 minutes to 1 hour
	1.150 to 1.175	30 to 45 minutes
	1.175 to 1.200	15 to 30 minutes
	1.200 to 1.225	0 to 15 minutes
High charge	1.225	Slow charge only

JOB SHEET #3

7. Advance charge rate control until meter registers at or slightly below charge rate; follow battery manufacturer's recommendation

CAUTION

If electrolyte temperature is greater than 125°F, decrease the charging rate to prevent a violent reaction or explosion.

8. Check battery's voltage with battery capacity tester or voltmeter

CAUTION

If the voltage reading is higher than 1.15 volts for a 12-volt battery, decrease the charging rate to prevent a violent reaction or explosion.

9. Disconnect AC plug from power source
 10. Disconnect charger cables from battery, removing negative cable first
 11. Turn all charger control settings to OFF position
- H. Remove battery vent caps
- I. Add water if necessary to bring electrolyte to proper level

CAUTION

Add water *slowly*. Too much water will cause electrolyte to spill out and corrode the battery case.

- J. If battery was fast charged, follow with a slow charge
- (NOTE: A fast charge will not fully charge a battery.)
- K. Remove eye protection, protective clothing, and vehicle fender covers
- L. Clean work area and put away equipment and materials

BATTERY SERVICE
UNIT XI

JOB SHEET #4 — LOAD-TEST A BATTERY

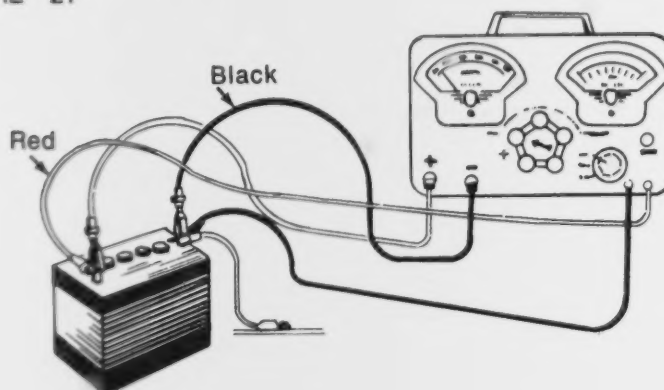
I. Equipment and materials

- A. 12-volt battery
- B. Battery capacity tester or voltmeter
- C. Appropriate conductors
- D. Eye protection
- E. Rubber gloves
- F. Rubber apron
- G. Appropriate service manual

II. Procedure

- A. Put on eye protection, rubber gloves, and rubber apron
- B. Connect capacity tester, following manufacturer's directions (Figure 21)

FIGURE 21



- C. Tighten rheostat knob to apply a load equal to three times the ampere/hour rating of battery being tested

(NOTE: The ampere/hour rating should be marked on the outside of the battery case.)

CAUTION

Do not apply the load to the battery for more than fifteen seconds at a time.

JOB SHEET #4

D. Read battery voltage at the end of fifteen seconds

(NOTE: If the voltage drops below 1.5 volts per cell in fifteen seconds, use the three-minute charge test. See Job Sheet #5.)

E. Loosen rheostat to relieve load at end of fifteen seconds

F. Turn off capacity tester

G. Disconnect capacity tester from battery, removing negative cable first

H. Remove eye protection, rubber gloves, and rubber apron

I. Clean work area and put away equipment and materials

BATTERY SERVICE
UNIT XI

JOB SHEET #5 — CHARGE-TEST A BATTERY FOR THREE MINUTES

I. Equipment and materials

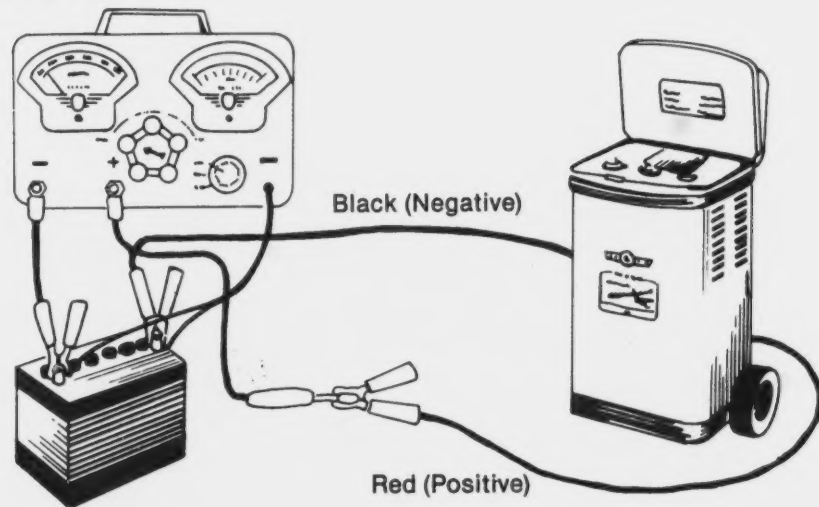
- A. 12-volt battery
- B. Adjustable, fast-rate battery charger
- C. Battery capacity tester or voltmeter
- D. Appropriate conductors
- E. Eye protection
- F. Rubber gloves
- G. Rubber apron
- H. Appropriate service manual

II. Procedure

- A. Put on eye protection, rubber gloves, and rubber apron
- B. Connect capacity tester or voltmeter and charger to battery as shown in Figure 22

CAUTION
Follow tester manufacturer's directions.

FIGURE 22



JOB SHEET #5

- C. Turn on charger and adjust charging rate to 40 amperes
- D. Charge battery for three minutes
- E. With battery charger still in operation, read individual cell voltages on capacity tester or voltmeter

(NOTE: If cell voltages vary more than 0.1 volt, replace the battery.)

- F. Read total battery voltage

(NOTE: If total battery voltage is over 15.5 volts, the battery is unsatisfactory and must be given a long, slow charge and load tested again. If voltage under load test is less than 9.6 volts, replace the battery.)

- G. Turn off capacity tester or voltmeter and charger
- H. Disconnect tester and charger from battery, removing negative cables first
- I. Remove eye protection, rubber gloves, and rubber apron
- J. Clean work area and put away equipment and materials

BATTERY SERVICE UNIT XI

TEST

NAME _____

SCORE _____

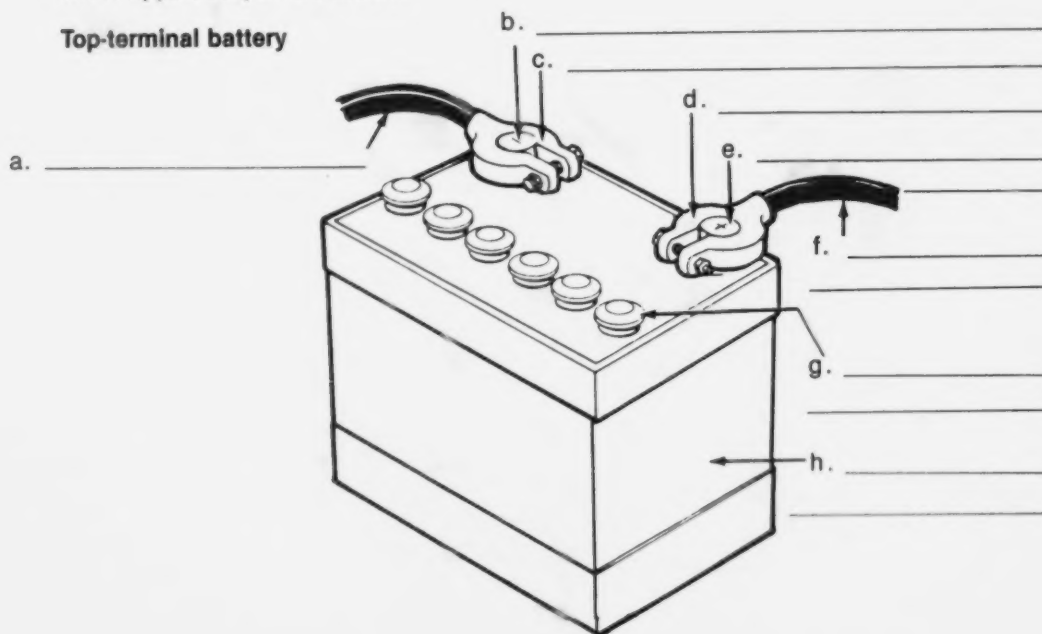
1. Match to their correct definitions terms associated with batteries. Write the correct numbers in the blanks.

- _____ a. Any electrical part connected to vehicle frame or engine block
- _____ b. Strength of current flowing through a circuit at one time
- _____ c. Source of electric current for vehicle and power source for cranking system
- _____ d. Amount of pressure that pushes or forces current in a circuit
- _____ e. Post made of lead that carries electrical charge between battery cells and battery cable
- _____ f. Complete path that electricity follows; consists of battery, wiring, electrical devices, and vehicle frame and metal body

1. Battery
2. Terminal
3. Amperage
4. Circuit
5. Ground
6. Voltage

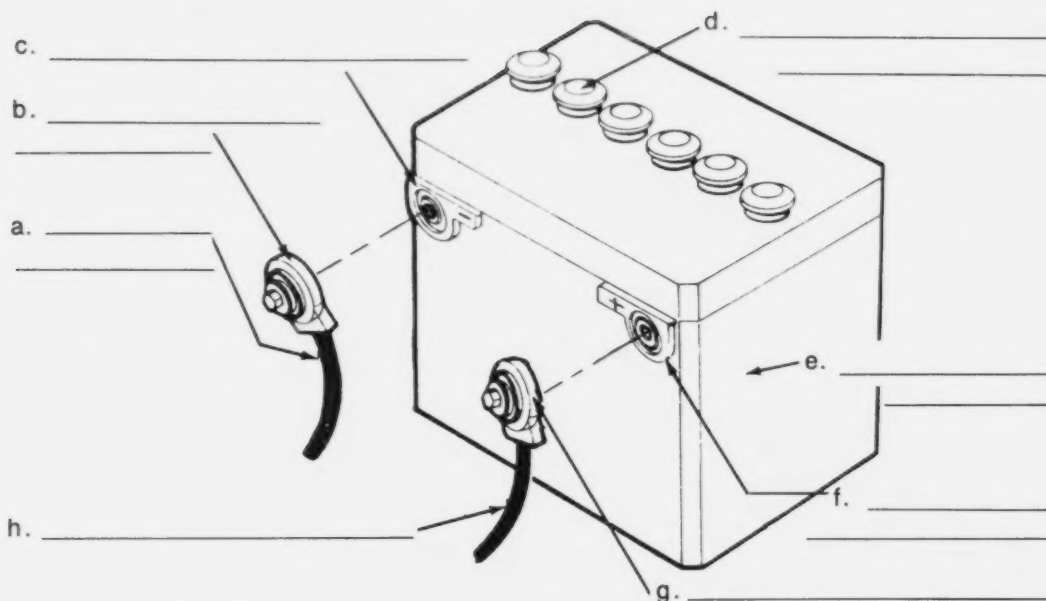
2. Label the parts of the batteries illustrated below. Write the correct names (and colors when applicable) in the blanks.

Top-terminal battery



TEST

Side-terminal battery



3. Match to their correct definitions terms associated with battery testing. Write the correct numbers in the blanks.

- | | |
|---|---|
| _____ a. Instrument used to measure amount of current in an electrical circuit | 1. Specific gravity |
| _____ b. Simple device used to check the presence of electrical current in a circuit | 2. Battery hydrometer |
| _____ c. Instrument used to measure specific gravity (weight) of battery electrolyte (solution) to determine strength of charge | 3. Electrolyte |
| _____ d. Combination ammeter and voltmeter with a carbon pile control used to test more than one electrical circuit | 4. Voltmeter |
| _____ e. Weight of solution compared to distilled water reading 1.000 | 5. Ammeter |
| _____ f. Instrument used to measure voltage between two points in an electrical circuit | 6. Battery, starter, charging system tester |
| _____ g. Solution of sulfuric acid (H_2SO_4) and water (H_2O) used in automotive wet-cell batteries | 7. Test light |

TEST

4. List five battery service safety rules.

- a. _____

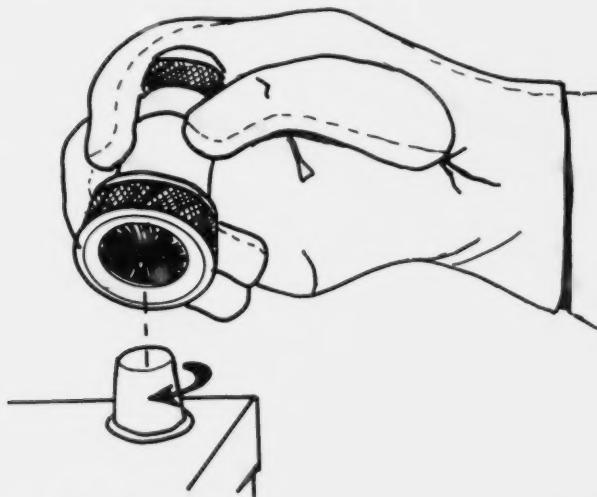
b. _____

c. _____

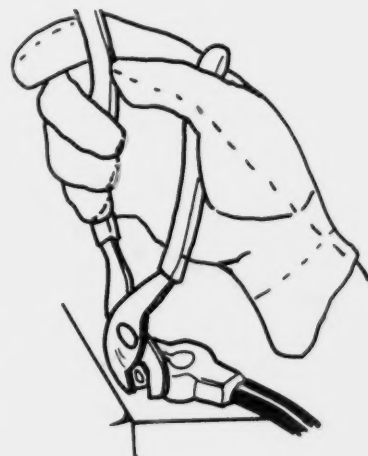
d. _____

e. _____

5. Label the following battery service specialty tools.

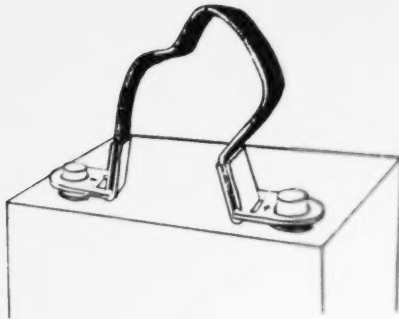


a. _____

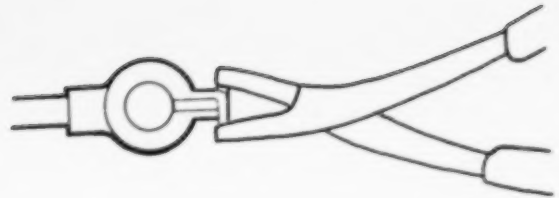


b. _____

TEST



c. _____



d. _____



e. _____



f. _____

TEST



g. _____

(NOTE: Test question 6 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

6. Demonstrate the ability to
 - a. Remove, clean, and reinstall a battery.
 - b. Check a battery with a hydrometer.
 - c. Charge a battery.
 - d. Load-test a battery.
 - e. Charge-test a battery for three minutes.

BATTERY SERVICE
UNIT XI

ANSWERS TO TEST

1. a. 5 d. 6
b. 3 e. 2
c. 1 f. 4

2. **Top-terminal battery**
a. Negative cable
b. Negative terminal post (green)
c. Negative clamp
d. Positive clamp
e. Positive terminal post (red)
f. Positive cable
g. Vent caps (cell covers)
h. Battery casing

Side-terminal battery

- a. Negative cable
b. Negative terminal connector (black)
c. Negative terminal
d. Vent caps (cell covers)
e. Battery casing
f. Positive terminal
g. Positive terminal connector (blue)
h. Positive cable

3. a. 5 e. 1
b. 7 f. 4
c. 2 g. 3
d. 6

4. Answer should include any five of the following
- a. Do not allow battery electrolyte to spill or to come in contact with clothing, skin, eyes, or painted surfaces of vehicle
 - b. Wear appropriate eye protection, rubber gloves, and rubber apron at all times when servicing batteries
 - c. Use fender covers to protect vehicle finish
 - d. Remove all jewelry before servicing battery
 - e. Keep sparks and flames away from battery at all times; gases (hydrogen and oxygen) given off by a battery are very explosive
 - f. Never short or ground battery during servicing as this may cause battery to explode
 - g. Always disconnect negative cable *first* to prevent arcing in the terminal and possible explosion

ANSWERS TO TEST

- h. Always reconnect negative cable *last* to prevent arcing in the terminal and possible explosion
 - i. Always observe polarity when connecting and disconnecting cables
 - j. If battery begins to bulge, spurt, or react violently during charging, stop charging and stand clear
 - k. Never charge or jump start a frozen battery
 - l. Never fast charge a maintenance-free (sealed) battery
 - m. Always turn off charger *before* connecting to or disconnecting from battery
 - n. Never charge a battery in a closed, unventilated room
 - o. Avoid breathing fumes from battery that is being charged
 - p. When using jumper cables, connect the negative ground cable to the frame, engine bracket, or other suitable ground, *never* to the battery terminal
5. a. Terminal cleaner
 b. Battery pliers
 c. Carrying strap
 d. G.M. spring-cable pliers
 e. Clamp puller
 f. Battery clamp spreader
 g. Wire brush
6. Performance skills evaluated to the satisfaction of the instructor

ENGINE COOLING SYSTEM UNIT XII

UNIT OBJECTIVE

After completing this unit, the student should be able to identify, remove, and replace various components of the engine cooling system. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with engine cooling systems.
2. State the purpose of the engine cooling system.
3. Describe the two basic methods of cooling internal-combustion engines.
4. List the functions of an engine cooling system.
5. Identify basic components of an engine cooling system.
6. Identify the parts of a cross-flow aluminum/plastic radiator.
7. Explain radiator pressure cap operation.
8. Label the components of a coolant reserve system.
9. State reasons for using permanent-type antifreeze in the cooling system.
10. Match types of thermostats to their correct names.
11. State reasons for replacing a thermostat only with one specified by manufacturer.
12. List safety rules to observe when working on an engine cooling system.
13. Demonstrate the ability to
 - a. Remove and replace a water pump.
 - b. Remove and replace a radiator.
 - c. Test antifreeze solution.

ENGINE COOLING SYSTEM
UNIT XII

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Assignment Sheet #1 — Complete Engine Cooling System Safety Rules
- E. Answers to assignment sheet
- F. Job sheets
 - 1. Job Sheet #1 — Remove and Replace a Water Pump
 - 2. Job Sheet #2 — Remove and Replace a Radiator
 - 3. Job Sheet #3 — Test Antifreeze Solution
- G. Test
- H. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Obtain materials to supplement unit.
 - 1. Samples of various thermostats, radiator caps, and water pumps for class discussion

(NOTE: Contact a local salvage operation to obtain these materials and the radiators listed below.)
 - 2. Copper and brass, aluminum, and aluminum/plastic cross-flow and down-flow radiators

(NOTE: Cut away sections of the radiators to expose tubes and fins or ribbons and cells for class discussion.)
 - 3. Equipment and materials necessary for job sheet performance

SUGGESTED ACTIVITIES

4. Competency profiles

(NOTE: Order competency profiles from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTION:

- Explain that many collisions cause damage to cooling system components such as radiators, fans, shrouds, coolant recovery systems, water pumps, belts, and hoses, and that the auto-body technician must be able to remove and replace any part as necessary to restore the vehicle to its original condition.

E. Discuss unit and specific objectives.

F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with engine cooling systems.

SUGGESTIONS:

- Explain that the use of appropriate terms helps when ordering parts and helps in communicating with customers and co-workers. The use of appropriate terms also improves professionalism.
 - Show students actual items to illustrate appropriate terms.
2. Use Information Sheet, Section II to discuss the purpose of the engine cooling system.

SUGGESTIONS:

- Explain that the cooling system extends engine life, and that fuel burns more efficiently at specified operating temperatures.
- Discuss how the cooling system also provides heat for the passenger compartment and assists in defrosting windshields.
- Explain that automobiles equipped with automatic transmissions have radiators with oil coolers either connected to or built into the inlet or outlet tank. Oil coolers cool the fluid by circulating it through the radiator and back to the transmission.

SUGGESTED ACTIVITIES

3. Use Information Sheet, Section III to discuss the two basic methods of cooling internal-combustion engines.

SUGGESTIONS:

- Use an automobile as a model to point out the various components (fan, shroud, radiator fins or cells) that move air through the radiator.
 - Use an automobile as a model to point out the components (water pump, thermostat, radiator) that circulate and regulate liquid coolant through the system.
 - Explain how in liquid-cooled engines air and liquid work together to maintain an efficient operating temperature.
4. Use Information Sheet, Section IV to explain the functions of the engine cooling system.
 5. Use Information Sheet, Section V to discuss the basic components of the engine cooling system.

SUGGESTIONS:

- Use an automobile as a model to point out the various components.
 - Have students identify the components in a variety of automobile makes and models so that they can become familiar with the different locations and styles.
 - Demonstrate and then have students complete Job Sheet #1 so that they may apply their knowledge of water pump and fan assemblies.
6. Use Information Sheet, Section VI to discuss the components of cross-flow aluminum/plastic radiators.

SUGGESTIONS:

- Show students components of a damaged radiator obtained from a local salvage operation or body shop.
- Explain that because the parts are not soldered together any component (tanks, oil coolers, core assembly, gaskets) on an aluminum/plastic radiator can be replaced in case of collision damage.
- Explain that dealerships repair aluminum/plastic radiators. Make arrangements with a dealership service department to give a demonstration to students on repairing an aluminum/plastic radiator.
- Demonstrate and then have students complete Job Sheet #2 so that they may apply their knowledge of radiators.

SUGGESTED ACTIVITIES

7. Use Information Sheet, Section VII to discuss the parts and operation of a radiator pressure cap.

SUGGESTIONS:

- Show students samples of radiator caps from various makes and models of automobiles.
 - Point out the gasket seal, pressure relief valve, and vacuum valve on each radiator cap.
 - Discuss radiator pressure cap operation and answer any questions that the students may have.
8. Use Information Sheet, Section VIII to discuss the components of a coolant reserve system.

SUGGESTIONS:

- Use an automobile as a model to point out the various components in the coolant reserve system.
 - Discuss the purpose and functioning of such a system.
9. Use Information Sheet, Section IX to explain the reasons for using permanent-type antifreeze in the cooling system.

SUGGESTIONS:

- Explain why antifreeze should be kept in the engine cooling system in both winter and summer.
 - Explain that when properly mixed with water, antifreeze solution cools better in the summer than does plain water.
 - Point out that radiators constructed of aluminum or of aluminum and plastic require an engine coolant specifically formulated for aluminum to prevent serious damage to the radiator.
 - Demonstrate and then have students complete Job Sheet #3.
10. Use Information Sheet, Sections X and XI to discuss thermostat types and operation.

SUGGESTIONS:

- Show students examples of various thermostats used on different makes and models of vehicles.

SUGGESTED ACTIVITIES

- Show samples of thermostats with different temperature ratings.
 - Discuss thermostat operation. Explain in your discussion that the thermostat controls the temperature of the coolant in the engine cooling system by regulating coolant flow. When the coolant is cold, the thermostat remains closed and allows the coolant to circulate only in the engine until a predetermined temperature is reached. When this temperature is reached, the thermostat opens and allows coolant to flow through the radiator.
 - Stress the need to use only the thermostat specified by the manufacturer when replacing a thermostat.
11. Use Information Sheet, Section XII to discuss safety rules to observe when working on engine cooling systems.

SUGGESTIONS:

- Point out and explain the safety hazards associated with engine cooling systems.
 - Stress the importance of observing all engine cooling system and shop safety rules. Explain any safety rules or regulations specific to your teaching methods or shop.
 - Have students complete Assignment Sheet #1 to reinforce their knowledge of safety rules.
- G. Give test.
- H. Critique test and discuss in class.
- I. Reteach if necessary.
- J. Complete appropriate section of competency profiles.
- III. Unit references
- A. *Aluminum-Plastic Radiator, Bulletin 16002.02.1*. Warren, Michigan: General Motors Corporation, Product Service Training, 1985.
 - B. Crouse, William H., and Donald L. Anglin. *Automotive Engines*, 5th ed. New York: Gregg Division, McGraw-Hill Book Company, 1976.
 - C. Crouse, William H. *Automotive Mechanics*, 8th ed. New York: Gregg Division, McGraw-Hill Book Company, 1980.
 - D. Glenn, Harold I. *Auto Mechanics*. Peoria, Illinois: Charles A. Bennett Company, 1962.

SUGGESTED ACTIVITIES

- E. Hendrix, Laborn J., "Bud." *Heavy Equipment Mechanic*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1985.
- F. Stockel, Martin W. *Auto Mechanics Fundamentals*. Homewood, Illinois: Goodheart-Willcox Company, 1969.
- G. Stockel, Martin W. *Auto Service and Repair*. Homewood, Illinois: Goodheart-Willcox Company, 1969.
- H. Tobolt, William K., and Jud Purvis. *Motor Services Automotive Encyclopedia*. Homewood, Illinois: Goodheart-Willcox Company, 1965.

ENGINE COOLING SYSTEM UNIT XII

INFORMATION SHEET

I. Terms and definitions

- A. Water pump — Centrifugal pump mounted at front of engine; functions to circulate coolant throughout engine cooling system
- B. Radiator — Device for holding enough coolant with sufficient heat transfer capabilities to satisfactorily maintain engine temperature in all driving conditions
- C. Coolant — Liquid that circulates through cooling system to transfer engine heat

(NOTE: The best results are achieved when the coolant is 50 percent water and 50 percent antifreeze.)

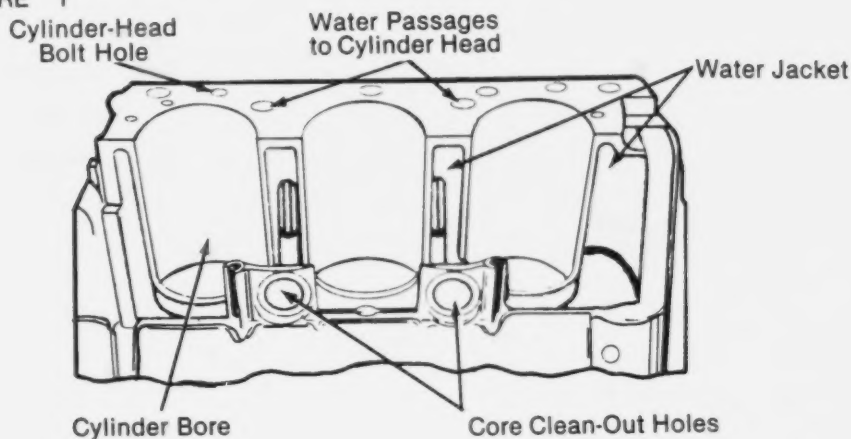
- D. Coolant reserve tank — Plastic container, usually mounted on inner fender; functions as a recovery system by accepting hot coolant as it expands and returning it to radiator as it cools

(NOTE: The coolant reserve tank or system is sometimes called the *cooling-system expansion tank* or the *coolant recovery system*.)

- E. Water jackets — Passages through the block and cylinder head that allow coolant to circulate around cylinders, valves, and combustion chambers (Figure 1)

EXAMPLE:

FIGURE 1



From *Automotive Mechanics*, 8th ed., by William H. Crouse. Used with permission of Gregg Division, McGraw-Hill Book Company.

INFORMATION SHEET

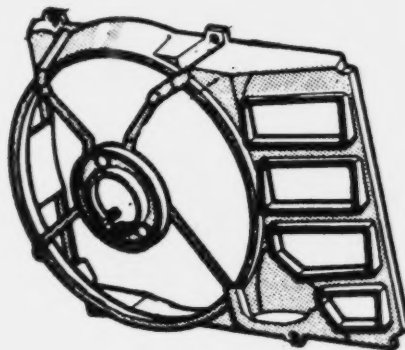
- F. Thermostat — Heat-controlled valve used in cooling system to regulate flow of coolant between cylinder block and radiator, thereby maintaining desired temperature
- G. Radiator pressure cap — Device designed to increase pressure within the cooling system several pounds per square inch (psi), thus allowing coolant to circulate at higher temperatures without evaporating

(NOTE: The temperature required to boil water increases as pressure in the cooling system increases. One additional pound of pressure per square inch raises the boiling point of water approximately 3 degrees Fahrenheit.)

- H. Shroud — Funnel-like structure attached to radiator and extending around and behind fan; used to make fan more effective in pulling air through the radiator core (Figure 2)

EXAMPLE:

FIGURE 2



Used with permission of Chrysler Corporation.

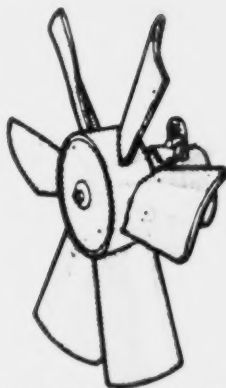
- I. Fan — Bladed device generally mounted on water pump hub assembly; designed to move a large volume of air through openings in radiator core (Figure 3)

(NOTE: On most front-wheel drive automobiles, the fan is powered by a 12-volt electric motor mounted on the fan shroud. The fan motor is turned on and off as required by a heat-sensor switch, which is usually mounted on the radiator tank.)

INFORMATION SHEET

EXAMPLE:

FIGURE 3



Used with permission of Chrysler Corporation.

J. Radiator core — That part of radiator through which coolant and air circulate to cool the coolant

(NOTE: Radiator cores are of five basic types. The two most common types used in automobiles are the tube-and-fin core illustrated in Figure 4 and the ribbon-cellular core illustrated in Figure 5.)

EXAMPLES:

FIGURE 4: Tube-and-Fin Core

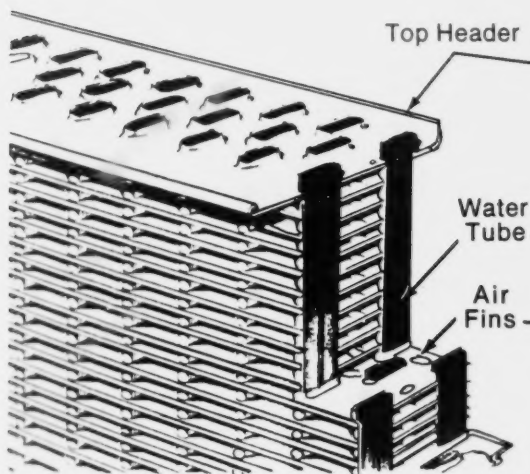
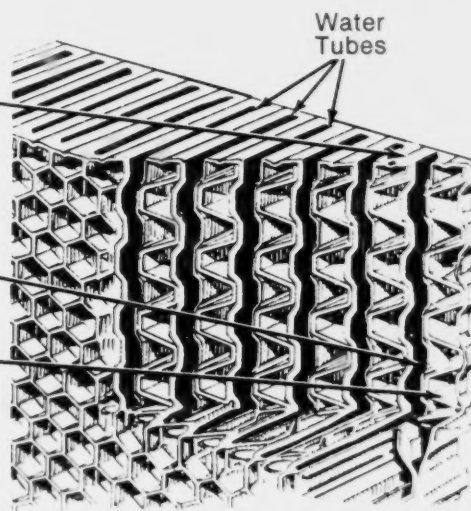


FIGURE 5: Ribbon-Cellular Core



From *Automotive Mechanics*, 8th ed., by William H. Crouse. Used with permission of Gregg Division, McGraw-Hill Book Company.

INFORMATION SHEET

K. Vacuum brazing — Process of brazing aluminum without the use of flux

(NOTE: Flux contains salt that causes corrosion, which can damage aluminum materials and the total cooling system.)

II. Purpose of the engine cooling system — To keep the engine at its most efficient operating temperature during all engine speeds and operating conditions

III. Two basic methods of cooling internal-combustion engines

A. Air cooling

1. Cylinders are semi-independent; they are not grouped in a block
2. Metal fins on heads and cylinders help radiate heat from engine
3. Special shrouds and blowers are used on some air-cooled engines to improve air circulation around cylinders and heads
4. No longer common method for cooling automobile engines, although engines for airplanes, motorcycles, power lawn mowers, and so forth are air-cooled

B. Liquid cooling

1. Liquid coolant (water and antifreeze solution) is circulated around cylinders to absorb heat from cylinder walls
2. Coolant is heated as it passes through engine
3. Hot coolant then flows through radiator in which the heat in coolant is passed on to air that is flowing through radiator
4. Most common method for cooling automotive engines

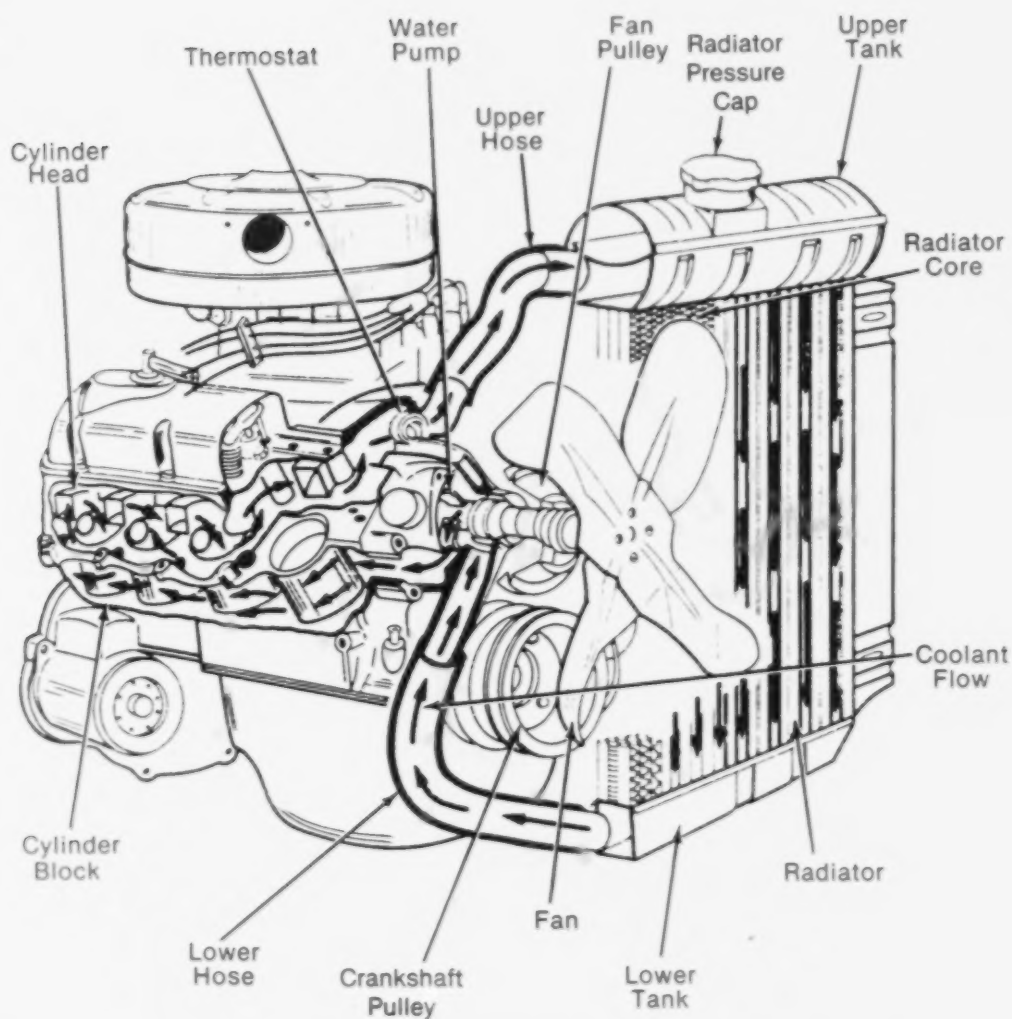
IV. Functions of the engine cooling system

- A. Removing surplus or unwanted heat
- B. Maintaining an efficient temperature under all operating conditions
- C. Bringing engine to operating temperature as soon after starting as possible
- D. Transferring heat to passenger compartment and windshield defrosting system in automobiles equipped with hot-water heaters

INFORMATION SHEET

V. Basic components of an engine cooling system (Figure 6)

FIGURE 6



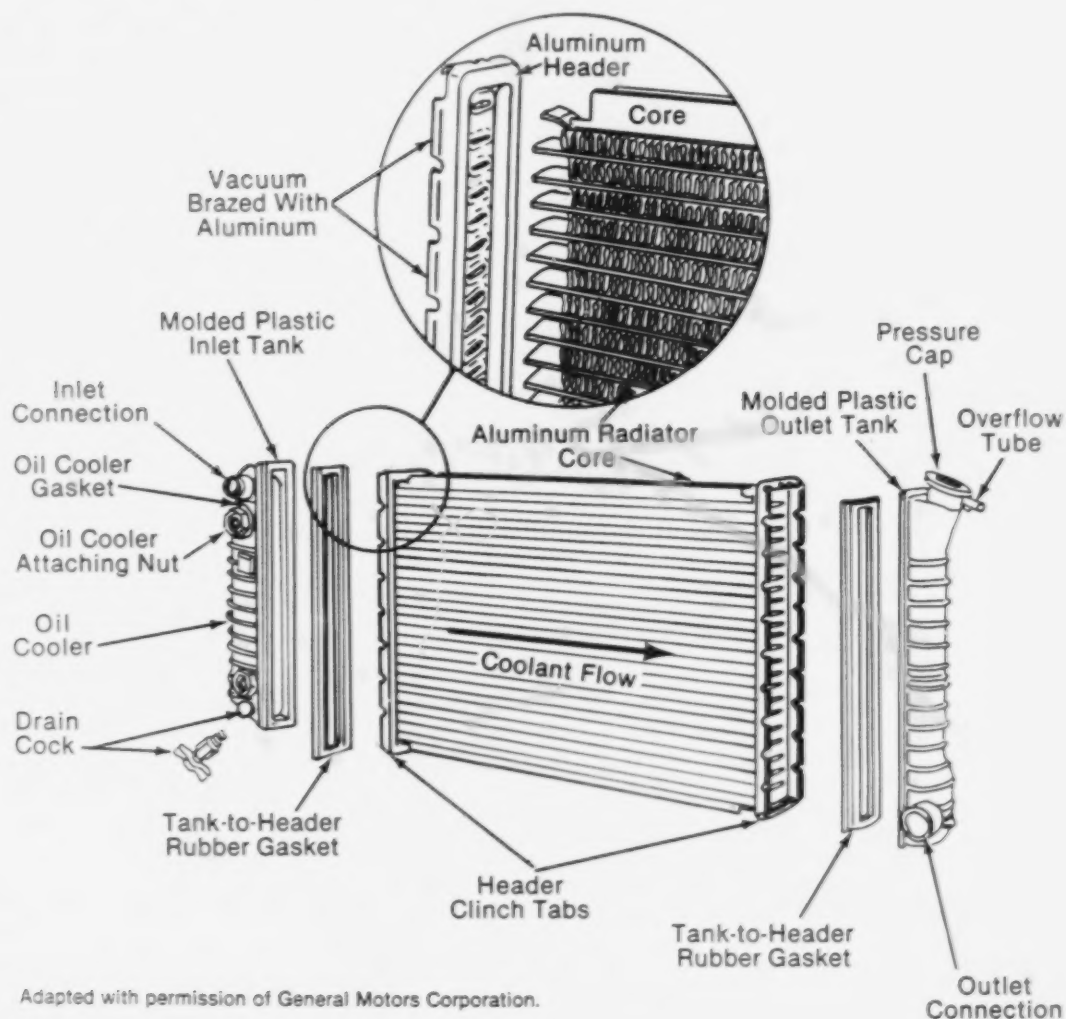
From *Automotive Mechanics*, 8th ed., by William H. Crouse. Used with permission of Gregg Division, McGraw-Hill Book Company.

INFORMATION SHEET

VI. Parts of a cross-flow aluminum/plastic radiator (Figure 7)

(NOTE: Aluminum/plastic cross-flow radiators are similar in function and appearance to other cross-flow radiators; however, their components are not soldered together, so they are easily removed for service. Top and bottom ribs on the radiator core add strength to the core, and saw cuts in these ribs allow for expansion and contraction during temperature changes. Tank-to-header gaskets are made of high-temperature rubber, and additional strength is added to the core by vacuum brazing the headers to the core assembly. Inlet and outlet tanks are molded of high-temperature nylon-reinforced plastic and are clamped to the core assembly with clinch tabs designed to be clinched and unclined three times before core replacement is necessary.)

FIGURE 7



Adapted with permission of General Motors Corporation.

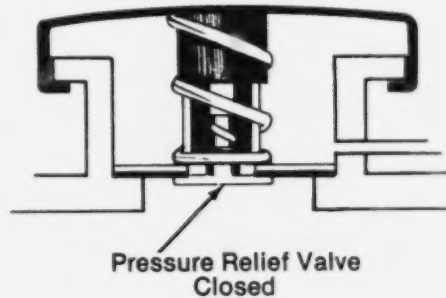
INFORMATION SHEET

VII. Radiator pressure cap operation (Figures 8-12)

- A. Spring-loaded pressure relief valve in radiator cap remains closed until cooling system pressure reaches a predetermined pressure

EXAMPLE:

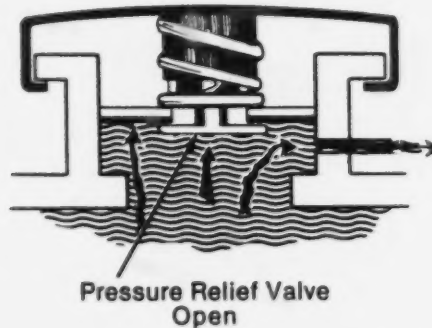
FIGURE 8



- B. Pressure relief valve opens when pressure in cooling system reaches the release range, usually somewhere between 14 psi and 17 psi

EXAMPLE:

FIGURE 9

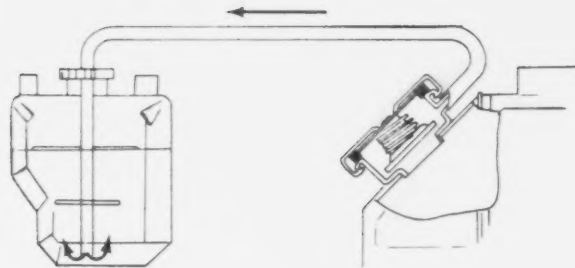


- C. As pressure is released through pressure relief valve in radiator cap, coolant is forced into coolant reserve tank

EXAMPLE:

INFORMATION SHEET

FIGURE 10

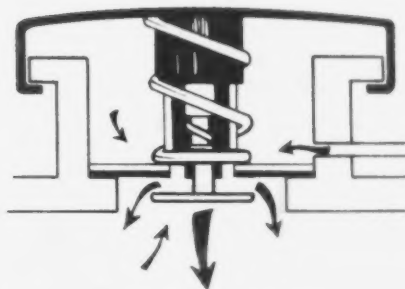


From *Automotive Mechanics*, 8th ed., by William H. Crouse. Used with permission of Gregg Division, McGraw-Hill Book Company.

- D. As coolant in reserve tank cools and contracts, vacuum valve in radiator cap opens and allows coolant to return to radiator

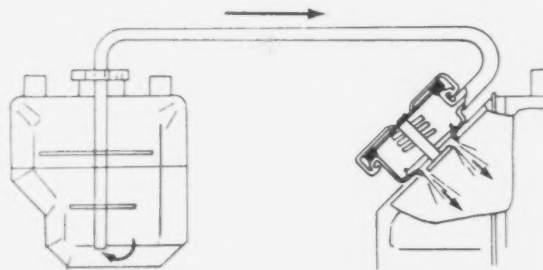
EXAMPLES:

FIGURE 11



Vacuum Valve Open

FIGURE 12

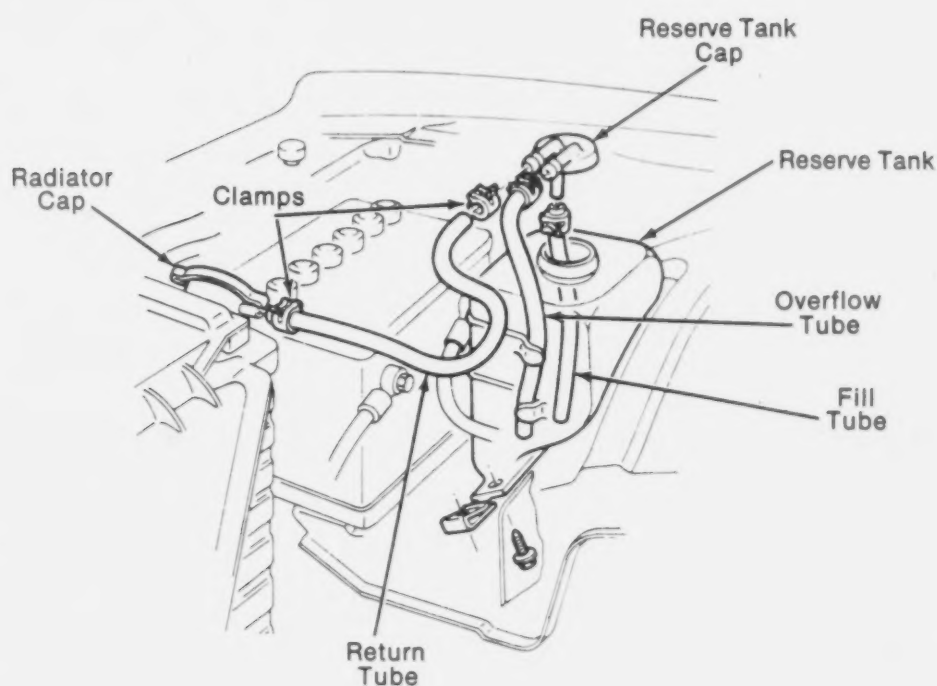


From *Automotive Mechanics*, 8th ed., by William H. Crouse. Used with permission of Gregg Division, McGraw-Hill Book Company.

INFORMATION SHEET

VIII. Components of a coolant reserve system (Figure 13)

FIGURE 13



From *Automotive Engines*, 5th ed., by William H. Crouse and Donald L. Anglin. Used with permission of Gregg Division, McGraw-Hill Book Company.

IX. Reasons for using permanent-type antifreeze in the cooling system

- A. Prevents coolant from freezing
- B. Has higher boiling point than water and thus prevents loss of coolant due to evaporation
- C. Reduces corrosive action of water
- D. Contains additives that lubricate water pump

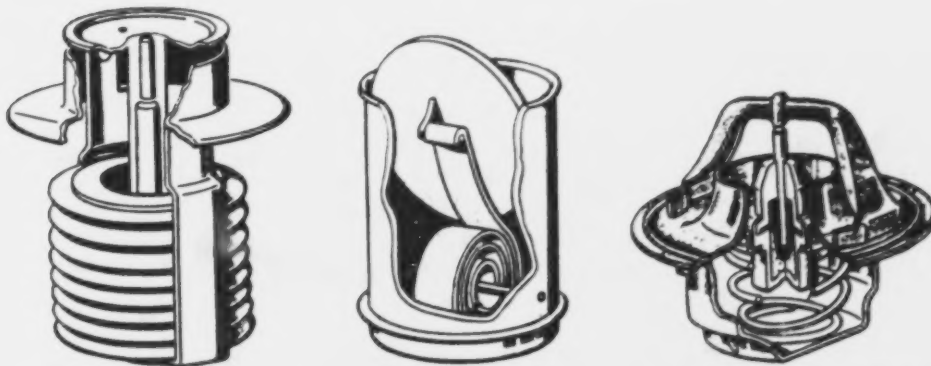
INFORMATION SHEET

X. Types of thermostats (Figures 14-16)

FIGURE 14: Bellows

FIGURE 15: Bimetal

FIGURE 16: Wax Pellet



From *Automotive Engines*, 5th ed., by William H. Crouse and Donald L. Anglin. Used with permission of Gregg Division, McGraw-Hill Book Company.

XI. Reasons for using only manufacturer-specified thermostat

- A. Thermostat is designed to open at specific temperature selected by manufacturer to suit operating requirements of engine and antifreeze used
- B. Thermostat is designed to keep specific vehicle's exhaust emissions at an acceptable level
- C. Thermostat is designed to provide good windshield defrosting and heater performance during the winter
- D. Thermostat is designed to allow vehicle's computerized engine control systems to function properly

XII. Safety rules to observe when working on an engine cooling system

- A. Keep hands away from moving parts (fans, belts, and pulleys) when engine is running
- B. Avoid contact with hot parts
- C. Avoid contact with caustics, fluxes, and acids
- D. Do not remove radiator pressure cap when engine is hot
- E. Turn off engine when tightening hose clamps or making other adjustments
- F. Wear appropriate eye protection and protective clothing
- G. Do not stand in plane of fan when engine is running

ENGINE COOLING SYSTEM
UNIT XII

ASSIGNMENT SHEET #1 — COMPLETE ENGINE COOLING SYSTEM SAFETY RULES

NAME _____ SCORE _____

It is important that auto-body technicians know and observe shop and job-specific safety rules at all times.

Treat this assignment sheet as a self-test, and do not refer to the information sheet to complete the following safety rules. Fill in the blanks with the complete word or words. When you have completed the assignment, exchange with a class member's assignment sheet. Refer to Information Sheet, Section XII to grade the class member's assignment sheet. Count each blank—regardless of the number of words it contains—as 5 points. Perfect score is 100 percent.

- A. Keep _____ away from moving parts (_____, _____, and _____) when engine is running
- B. Avoid contact with _____ parts
- C. Avoid contact with _____, _____, and _____
- D. Do not remove _____ when engine is _____
- E. Turn off _____ when tightening _____ or making other _____
- F. Wear appropriate _____ and _____
- G. Do not stand in _____ when engine is _____

ENGINE COOLING SYSTEM
UNIT XII

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

- A. Hands; fans, belts, pulleys
- B. Hot
- C. Caustics, fluxes, acids
- D. Radiator pressure cap, hot
- E. Engine; hose clamps, adjustments
- F. Eye protection, protective clothing
- G. Plane of fan, running

ENGINE COOLING SYSTEM
UNIT XII

JOB SHEET #1 — REMOVE AND REPLACE A WATER PUMP

I. Equipment and materials

- A. Vehicle
- B. Combination-end wrenches, $\frac{7}{16}$ inch to $\frac{3}{4}$ inch
- C. Sockets, $\frac{3}{8}$ inch to $\frac{3}{4}$ inch to fit $\frac{3}{8}$ -inch drive
- D. Ratchet, $\frac{3}{8}$ -inch drive
- E. Extension, $\frac{3}{8}$ -inch drive, approximately 6 inches long
- F. Hose-clamp pliers
- G. Gasket scraper
- H. Gasket sealer
- I. Torque wrench
- J. Standard screwdriver
- K. Appropriate coolant
- L. Drain pan
- M. Radiator fill can
- N. Masking tape
- O. Vehicle service manual
- P. Eye protection
- Q. Fender cover
- R. Shop towels

II. Procedure

- A. Put on eye protection
- B. Place fender cover on vehicle
- C. Drain cooling system

JOB SHEET #1

D. Remove drive belt(s)

E. Remove fan

(NOTE: Usually the fan must be removed before the fan shroud.)

F. Remove fan shroud

G. Determine type of water pump

(NOTE: Some water pumps are small, attached to the front engine housing, and usually held in place with four bolts. Other pumps are attached to the block and require lower-hose removal.)

H. Remove water pump

1. Remove lower hose if required

2. Remove water-pump retaining bolts and stick to a piece of masking tape in order of removal

(NOTE: Air-conditioning and power-steering brackets may require loosening or removal.)

I. Remove gasket from pump

(NOTE: Replace gasket if it is damaged or worn.)

J. Clean all gasket material and rust from gasket surface

K. Apply gasket sealer to gasket surface

L. Install gasket on water pump

(NOTE: It is sometimes necessary to place the gasket on the block for convenience of installation.)

M. Reinstall water pump, starting retaining bolts in the same holes they came out of

N. Tighten water-pump retaining bolts uniformly and torque to specifications

O. Reattach lower hose if applicable

P. Reinstall fan shroud

Q. Reinstall fan assembly

(NOTE: Make sure that the fan is placed correctly to draw air through the radiator.)

JOB SHEET #1

R. Install drive belt(s)

(NOTE: Replace belt(s) if damaged or worn. Make sure that new belt meets manufacturer's specifications.)

S. Follow manufacturer's recommended procedure for water pump break-in

T. Close radiator drain cock and fill radiator with recommended coolant

(NOTE: Some foreign and domestic automobiles are equipped with low-profile radiators that become air blocked when filled with coolant. Refer to vehicle service manual for specific instructions to prevent such air blockage. Also, radiators constructed of aluminum or aluminum and plastic require an engine coolant specifically formulated for aluminum. Refer to service manual for specifications.)

U. Start engine and allow to warm up

CAUTION

Do not stand in plane of fan when engine is running.

V. Check for leaks; make necessary adjustments or repairs

W. Recheck coolant level

(NOTE: After the engine is warmed up and the thermostat opens, the coolant level may drop.)

X. Remove eye protection

Y. Remove fender cover

Z. Clean work area and put away equipment and materials

ENGINE COOLING SYSTEM
UNIT XII

JOB SHEET #2 — REMOVE AND REPLACE A RADIATOR

- I. Equipment and materials
 - A. Vehicle
 - B. Combination-end wrenches, $\frac{3}{8}$ inch to $\frac{3}{4}$ inch
 - C. Sockets, $\frac{3}{8}$ inch to $\frac{3}{4}$ inch to fit $\frac{3}{8}$ -inch drive
 - D. Ratchet, $\frac{3}{8}$ -inch drive
 - E. Extension, $\frac{3}{8}$ -inch drive, approximately 4 inches long
 - F. Hose-clamp pliers
 - G. Standard screwdriver
 - H. Air compressor
 - I. Appropriate coolant
 - J. Drain pan
 - K. Radiator fill can
 - L. Vehicle service manual
 - M. Eye protection
 - N. Fender cover
 - O. Shop towels
- II. Procedure
 - A. Put on eye protection
 - B. Place fender cover on vehicle
 - C. Open drain cock and drain radiator
 - D. Disconnect radiator hose from input tank
 - E. Disconnect radiator hose from output tank

JOB SHEET #2

- F. Remove fan-shroud attaching screws
- G. Move fan shroud toward back of engine and over fan assembly
- H. Disconnect automatic transmission oil cooler lines if used

(NOTE: To avoid damage to the fitting and radiator, use a back-up wrench when removing lines.)

- I. Remove radiator attaching bolts
- J. Remove radiator
- K. Clean radiator air passages with compressed air
- L. Check radiator mounting shell for breaks or cracks
- M. Reinstall radiator

(NOTE: Make sure that fan shroud is in place before radiator is reinstalled.)

1. Position radiator and start attaching bolts
2. Tighten attaching bolts securely

- N. Reattach transmission oil cooler lines if applicable and tighten securely

(NOTE: To prevent damage to the fittings and radiator, use a back-up wrench when reattaching lines.)

- O. Move fan shroud into place, install attaching screws, and tighten securely
- P. Inspect radiator hoses; replace if damaged or worn
- Q. Install hose to outlet tank and tighten clamps securely
- R. Install hose to inlet tank and tighten clamps securely
- S. Close radiator drain cock and fill radiator with recommended coolant

(NOTE: Some foreign and domestic automobiles are equipped with low-profile radiators that become air blocked when filled with coolant. Refer to vehicle service manual for specific instructions to prevent such air blockage. Also, radiators constructed of aluminum or aluminum and plastic require an engine coolant specifically formulated for aluminum. Refer to service manual for specifications.)

JOB SHEET #2

- T. Start engine and allow to warm up

CAUTION

Do not stand in plane of fan when engine is running.

- U. Check for leaks; make necessary adjustments or repairs

- V. Recheck coolant level

(NOTE: After the engine is warmed up and the thermostat opens, the coolant level may drop.)

- W. Remove eye protection

- X. Remove fender cover

- Y. Clean work area and put away equipment and materials

ENGINE COOLING SYSTEM
UNIT XII

JOB SHEET #3 — TEST ANTIFREEZE SOLUTION

I. Equipment and materials

- A. Vehicle
- B. Vehicle service manual
- C. Antifreeze hydrometer tester
- D. Voltmeter
- E. Eye protection
- F. Shop towels
- G. Pencil and paper for recording readings

II. Procedure

- A. Start engine and allow time for coolant to warm to operating temperature

CAUTION

Do not stand in plane of fan when engine is running.

- B. Put on eye protection
- C. If vehicle is equipped with coolant recovery system, remove cap from coolant reserve tank

(NOTE: If vehicle is equipped with a coolant recovery system, it is not necessary to remove the radiator pressure cap.)

- D. If vehicle is not equipped with a coolant recovery system, remove radiator pressure cap in the following manner
 - 1. Turn off engine and wait fifteen minutes
 - 2. Place shop towel over radiator cap and slowly turn cap counterclockwise as far as possible without pressing down on cap
 - 3. Allow time for pressure to escape and for system to stabilize
 - 4. Press down and finish removing cap

JOB SHEET #3

5. Restart vehicle engine and allow to run at idle speed

CAUTION

Do not stand in plane of fan when engine is running.

- E. Draw coolant into tester and empty several times to equalize temperature of tester and coolant
- F. Draw coolant into tester and take reading at eye level
1. Read first number or letter above liquid surface on float
 2. Note temperature of coolant
 3. Measure antifreeze content of water by comparing these two readings to chart on tester
- G. Make sure that antifreeze solution protects system to at least 10 Fahrenheit degrees lower than coldest temperature expected
- H. Add antifreeze if necessary

(NOTE: Radiators constructed of aluminum or aluminum and plastic require an engine coolant specifically formulated for aluminum. Refer to vehicle service manual for specifications.)

- I. Test coolant with voltmeter
1. Drop voltmeter probes into coolant
 2. Turn on voltmeter and take reading

(NOTE: If the voltmeter reading is 0 to 1 volt, the coolant is fine. If the voltmeter reading is 1+ or above, the coolant should be drained and replaced with a fresh solution.)

3. Turn off voltmeter
- J. Remove eye protection
- K. Clean work area and put away equipment and materials

ENGINE COOLING SYSTEM UNIT XII

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with engine cooling systems. Write the correct numbers in the blanks.

- | | |
|---|--------------------------|
| _____ a. Device for holding enough coolant with sufficient heat transfer capabilities to satisfactorily maintain engine temperature in all driving conditions | 1. Water jackets |
| _____ b. Plastic container, usually mounted on inner fender; functions as a recovery system by accepting hot coolant as it expands and returning it to radiator as it cools | 2. Coolant reserve tank |
| _____ c. Heat-controlled valve used in cooling system to regulate flow of coolant between cylinder block and radiator, thereby maintaining desired temperature | 3. Water pump |
| _____ d. Funnel-like structure attached to radiator and extending around and behind fan; used to make fan more effective in pulling air through the radiator core | 4. Radiator |
| _____ e. That part of radiator through which coolant and air circulate to cool the coolant | 5. Radiator pressure cap |
| _____ f. Process of brazing aluminum without the use of flux | 6. Radiator core |
| _____ g. Centrifugal pump mounted at front of engine; functions to circulate coolant throughout engine cooling system | 7. Fan |
| _____ h. Liquid that circulates through cooling system to transfer engine heat | 8. Shroud |
| _____ i. Passages through the block and cylinder head that allow coolant to circulate around cylinders, valves, and combustion chambers | 9. Vacuum brazing |
| _____ j. Device designed to increase pressure within the cooling system several pounds per square inch (psi), thus allowing coolant to circulate at higher temperatures without evaporating | 10. Thermostat |
| | 11. Coolant |

TEST

_____k. Bladed device generally mounted on water pump hub assembly; designed to move a large volume of air through openings in radiator core

2. State the purpose of the engine cooling system.

3. Discuss the two basic methods of cooling internal-combustion engines.

Air cooling

Liquid cooling

TEST

4. List the functions of the engine cooling system.

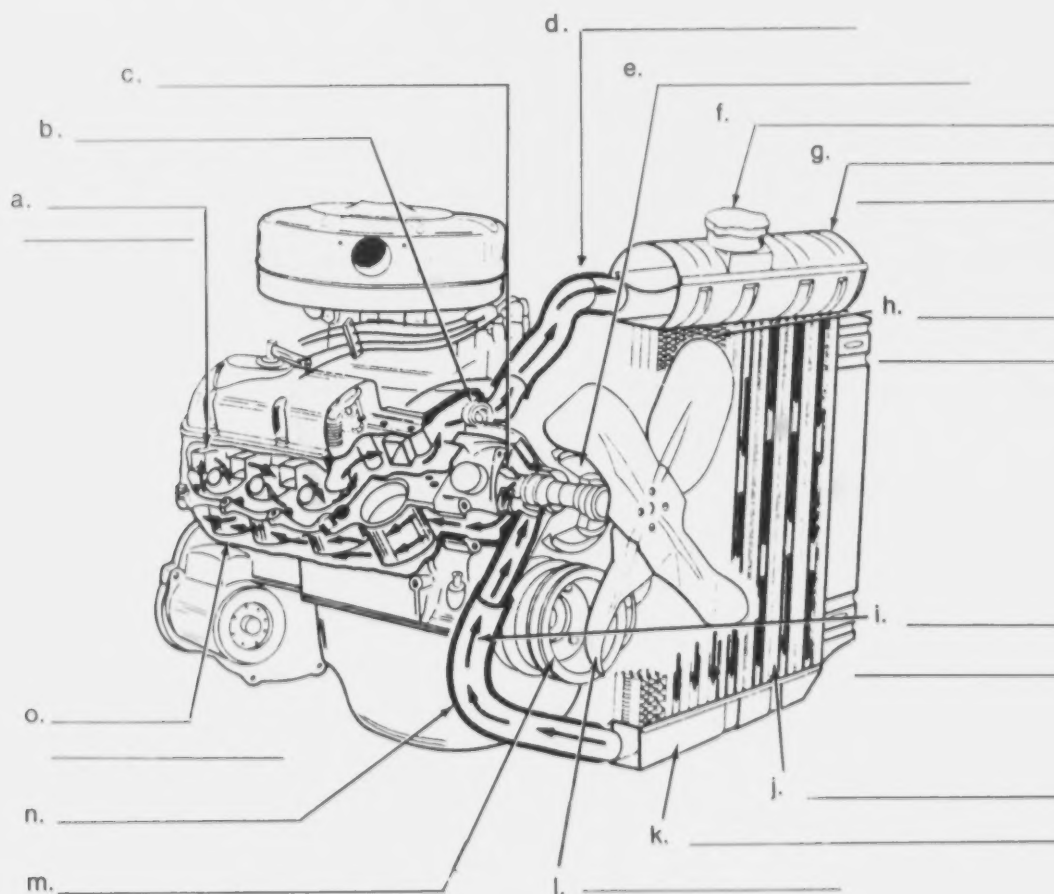
- a. _____
- b. _____
- c. _____
- d. _____

5. Identify basic components of the engine cooling system illustrated below. Write the correct names in the blanks.

Upper tank
Lower tank
Upper hose
Lower hose
Radiator pressure cap

Cylinder head
Cylinder block
Thermostat
Water pump
Coolant flow

Fan
Fan pulley
Crankshaft pulley
Radiator
Radiator core



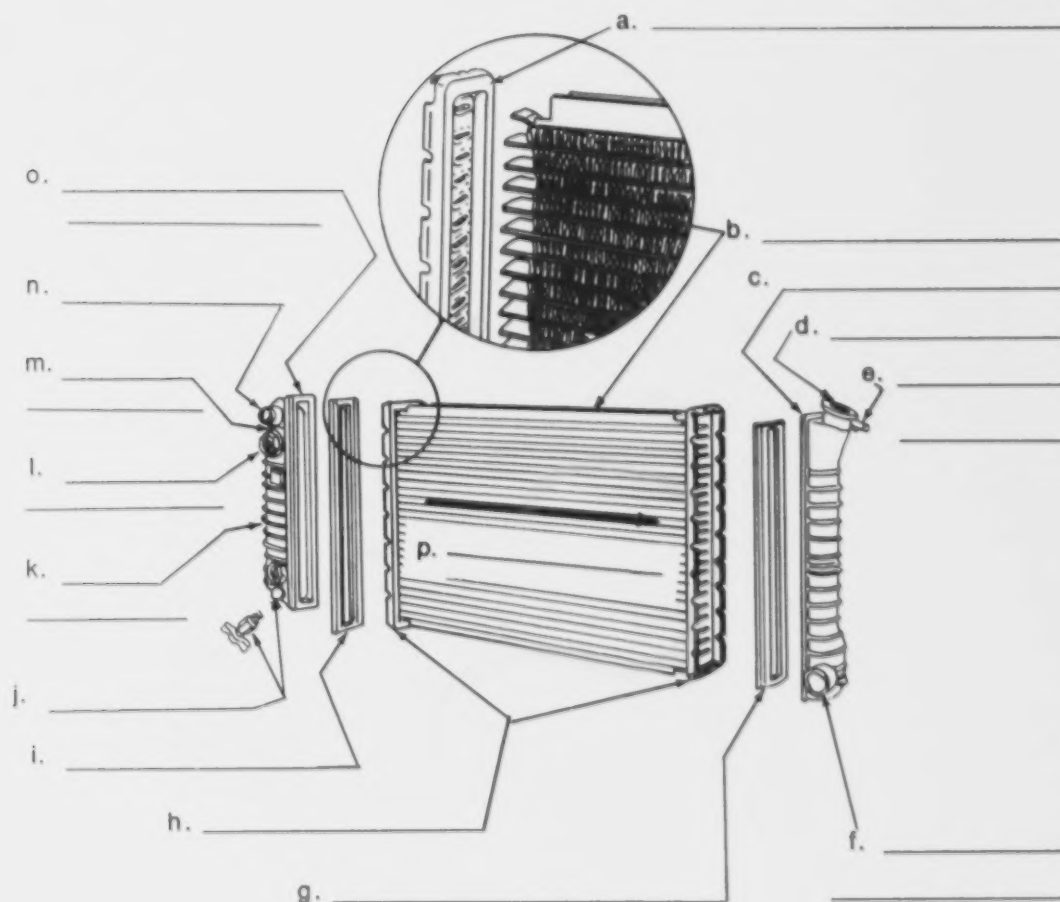
TEST

6. Identify the parts of the cross-flow aluminum/plastic radiator illustrated below. Write the correct names in the blanks.

Tank-to-header rubber gasket
Header clinch tabs
Molded plastic inlet tank
Pressure cap
Overflow tube

Aluminum header
Molded plastic outlet tank
Oil cooler attaching nut
Inlet connection
Outlet connection
Oil cooler

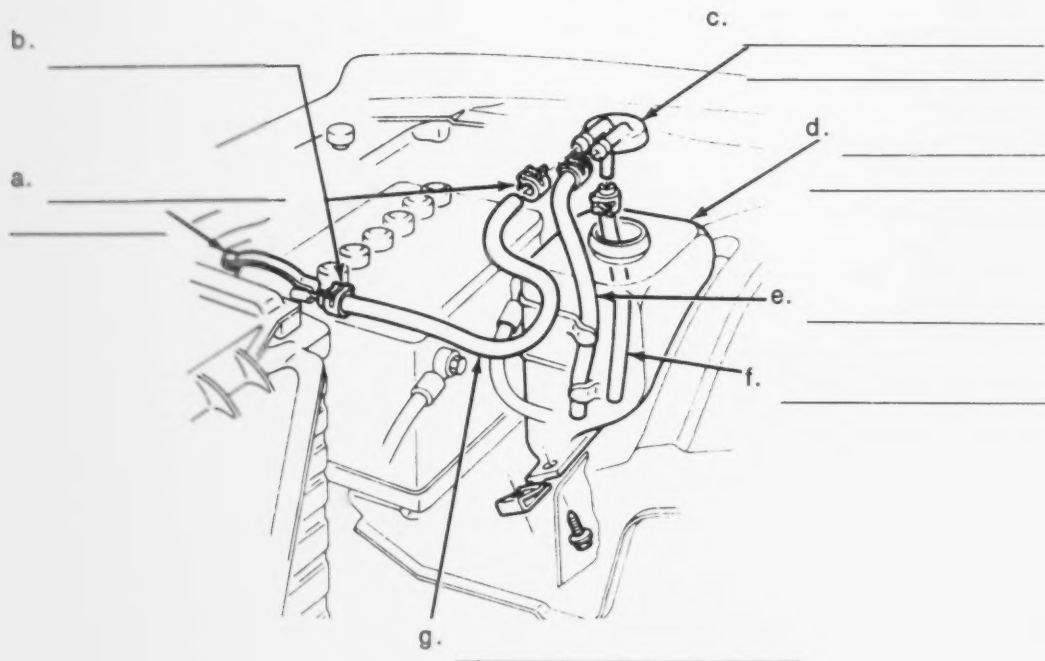
Drain cock
Oil cooler gasket
Aluminum radiator core
Coolant flow



TEST

7. Explain radiator pressure cap operation.

8. Label the components of the coolant reserve system illustrated below.



TEST

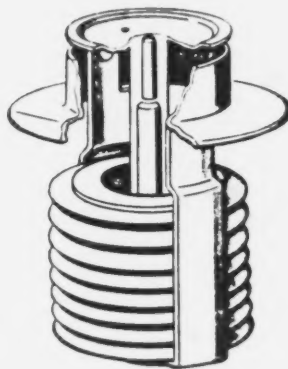
9. State reasons for using permanent-type antifreeze in the cooling system.

- a. _____
- b. _____
- c. _____
- d. _____

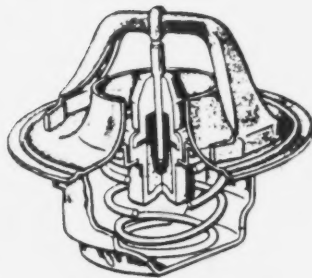
10. Match the following types of thermostats to their correct names. Write the correct numbers in the blanks.

- _____ a. Bellows
- _____ b. Bimetal
- _____ c. Wax pellet

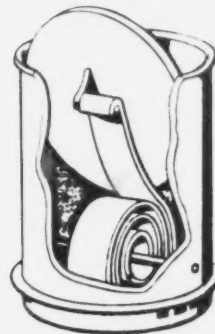
1.



2.



3.



11. State reasons for replacing a thermostat only with one specified by manufacturer.

- a. _____
- _____
- b. _____
- _____

TEST

c. _____

d. _____

12. List four safety rules to observe when working on an engine cooling system.

a. _____

b. _____

c. _____

d. _____

(NOTE: Test question 13 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

13. Demonstrate the ability to

a. Remove and replace a water pump.

b. Remove and replace a radiator.

c. Test antifreeze solution.

ENGINE COOLING SYSTEM UNIT XII

ANSWERS TO TEST

1. a. 4 e. 6 i. 1
 b. 2 f. 9 j. 5
 c. 10 g. 3 k. 7
 d. 8 h. 11

2. Purpose of the engine cooling system — To keep the engine at its most efficient operating temperature during all engine speeds and operating conditions

3. Discussion should include the following

Air cooling

- a. Cylinders are semi-independent; they are not grouped in a block
- b. Metal fins on heads and cylinders help radiate heat from engine
- c. Special shrouds and blowers are used on some air-cooled engines to improve air circulation around cylinders and heads
- d. No longer common method for cooling automobile engines, although engines for airplanes, motorcycles, power lawn mowers, and so forth are air cooled

Liquid cooling

- a. Liquid coolant (water and antifreeze solution) is circulated around cylinders to absorb heat from cylinder walls
- b. Coolant is heated as it passes through engine
- c. Hot coolant then flows through radiator in which the heat in coolant is passed on to air that is flowing through radiator
- d. Most common method of cooling automotive engines

4. a. Removing surplus or unwanted heat
- b. Maintaining an efficient temperature under all operating conditions
- c. Bringing engine to operating temperature as soon after starting as possible
- d. Transferring heat to passenger compartment and windshield defrosting system in automobiles equipped with hot-water heaters

5. a. Cylinder head i. Coolant flow
 b. Thermostat j. Radiator
 c. Water pump k. Lower tank
 d. Upper hose l. Fan
 e. Fan pulley m. Crankshaft pulley
 f. Radiator pressure cap n. Lower hose
 g. Upper tank o. Cylinder block
 h. Radiator core

ANSWERS TO TEST

6.

a. Aluminum header	g. Tank-to-header rubber gasket	l. Oil cooler attaching nut
b. Aluminum radiator core	h. Header clinch tabs	m. Oil cooler gasket
c. Molded plastic outlet tank	i. Tank-to-header rubber gasket	n. Inlet connection
d. Pressure cap	j. Drain cock	o. Molded plastic inlet tank
e. Overflow tube	k. Oil cooler	
f. Outlet connection		

7. Explanation should include the following
 - a. Spring-loaded pressure relief valve in radiator cap remains closed until cooling system pressure reaches a predetermined pressure
 - b. Pressure relief valve opens when pressure in cooling system reaches the release range, usually somewhere between 14 psi and 17 psi
 - c. As pressure is released through pressure relief valve in radiator cap, coolant is forced into coolant reserve tank
 - d. As coolant in reserve tank cools and contracts, vacuum valve in radiator cap opens and allows coolant to return to radiator

8.

a. Radiator cap	e. Overflow tube
b. Clamps	f. Fill tube
c. Reserve tank cap	g. Return tube
d. Reserve tank	

9.
 - a. Prevents coolant from freezing
 - b. Has higher boiling point than water and thus prevents loss of coolant due to evaporation
 - c. Reduces corrosive action of water
 - d. Contains additives that lubricate water pump

10.
 - a. 1
 - b. 3
 - c. 2

11.
 - a. Thermostat is designed to open at a specific temperature selected by manufacturer to suit operating requirements of engine and antifreeze used
 - b. Thermostat is designed to keep specific vehicle's exhaust emissions at an acceptable level
 - c. Thermostat is designed to provide good windshield defrosting and heater performance during the winter
 - d. Thermostat is designed to allow specific vehicle's computerized engine control systems to function properly

ANSWERS TO TEST

12. Answer should include any four of the following
 - a. Keep hands away from moving parts (fans, belts, pulleys) when engine is running
 - b. Avoid contact with hot parts
 - c. Avoid contact with caustics, fluxes, and acids
 - d. Do not remove radiator pressure cap when engine is hot
 - e. Turn off engine when tightening hose clamps or making other adjustments
 - f. Wear appropriate eye protection and protective clothing
 - f. Do not stand in plane of fan when engine is running

13. Performance skills evaluated to the satisfaction of the instructor

AIR-CONDITIONING SYSTEM UNIT XIII

UNIT OBJECTIVE

After completing this unit, the student should be able to identify components of an automotive air-conditioning system and describe the function of each component. The student should also be able to demonstrate safe and proper procedures for servicing the air-conditioning system. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with automotive air-conditioning systems.
2. Identify components of a basic automotive air-conditioning system.
3. Match air-conditioning system components to their correct descriptions/functions.
4. State safety rules for servicing an air-conditioning system.
5. State guidelines for protecting the air-conditioning system during service.
6. Select from a list problems caused by air in an air-conditioning system.
7. List problems caused by moisture in an air-conditioning system.
8. Demonstrate the ability to
 - a. Discharge and evacuate an automotive air-conditioning system.
 - b. Remove and replace a condenser.
 - c. Remove and replace a receiver/drier.
 - d. Charge an automotive air-conditioning system.
 - e. Leak-test an automotive air-conditioning system.

AIR-CONDITIONING SYSTEM
UNIT XIII

SUGGESTED ACTIVITIES

- I. Unit contents
 - A. Objective sheet
 - B. Suggested activities
 - C. Information sheet
 - D. Job sheets
 - 1. Job Sheet #1 — Discharge and Evacuate an Automotive Air-Conditioning System
 - 2. Job Sheet #2 — Remove and Replace a Condenser
 - 3. Job Sheet #3 — Remove and Replace a Receiver/Drier
 - 4. Job Sheet #4 — Charge an Automotive Air-Conditioning System
 - 5. Job Sheet #5 — Leak-Test an Automotive Air-Conditioning System
 - E. Test
 - F. Answers to test
- II. Instructor's guide
 - A. Review unit and plan presentation.
 - B. Order or obtain materials to supplement unit.
 - 1. Filmstrips

(NOTE: The following filmstrips are available from Teaching Aids Incorporated, P.O. Box 1798, Costa Mesa, California 92628-0798; phone 714-548-9321.)

 - a. *Basic Air Conditioning Systems*

(NOTE: This filmstrip explains the basic principles of refrigeration and the function and operation of typical automotive air-conditioning-system components.)

SUGGESTED ACTIVITIES

b. *Automotive Air Conditioner Explained*

- 1) "Basic Parts and Principles"
- 2) "Using the Equipment"
- 3) "Troubleshooting Problems"

(NOTE: This series of three filmstrips, three cassettes, and study guide shows how freon flows in the system; demonstrates correct procedures for making pressure checks, detecting leaks, and discharging the system; and details recommended procedures for correcting problems detected in the troubleshooting sequence.)

2. Case studies of accidents caused by improper handling of refrigerant

(NOTE: Write to the National Safety Council [NSC], 444 North Michigan Avenue, Chicago, Illinois 60611.)

3. Sample 1-pound cans of Refrigerant 12, can valves and adapters, refrigerant oil, various sizes of o-rings
4. Salvaged air-conditioning components to make mock-up and cut-away models for class discussion
5. Equipment and materials necessary for job sheet procedures
6. Manifold-gauge set, vacuum pump, electronic and torch-type leak detectors, and other equipment needed to service an air-conditioning system
7. Competency profiles

(NOTE: Competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074.)

C. Introduce unit.

SUGGESTIONS:

- Explain that today most automobiles have air conditioning as original equipment, and that most front-end collisions involve components of the air-conditioning system. For instance, the condenser is located in front of the radiator and is often damaged in front-end collisions and must be replaced or removed so that other repairs can be made.
- Explain that air-conditioner components are considered to be collision items and that the body shop technician is responsible for replacing damaged parts and restoring the air-conditioning system to its original condition.

SUGGESTED ACTIVITIES

- D. Provide students with unit.
- E. Discuss unit and specific objectives.
- F. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce students to terms associated with automotive air-conditioning systems.

SUGGESTIONS:

- Explain that using appropriate trade terminology improves professionalism and helps the technician communicate with customers, co-workers, and others in the trade.
 - Show students examples of appropriate terms, and use mock-up or cut-away views to illustrate specific terms.
2. Use Information Sheet, Section II to introduce students to the components of a basic automotive air-conditioning system.

SUGGESTIONS:

- Show filmstrip *Basic Air Conditioning Systems* or "Basic Parts and Principles" from series *Automotive Air Conditioner Explained*.
 - Point out the various components on different makes and models of automobiles.
3. Use Information Sheet, Section III to explain the functions of air-conditioning system components.

SUGGESTIONS:

- Show filmstrip *Basic Air Conditioning Systems* if you have not already shown it.
 - Discuss the principles of refrigeration and how these principles apply to an automotive air-conditioning system.
4. Use Information Sheet, Section IV to stress safety rules for servicing an automotive air-conditioning system.

SUGGESTIONS:

- Share with the class case studies of accidents caused by improper handling of refrigerant.
- Stress the fact that refrigerant becomes very poisonous when exposed to an open flame, and caution students against inhaling these vapors when testing for leaks with a torch-type leak detector.

SUGGESTED ACTIVITIES

- Caution students against allowing escaping refrigerant to come in contact with their skin or eyes. Use a wet towel to demonstrate how refrigerant freezes anything it contacts.
5. Use Information Sheet, Section V to review guidelines for protecting the air-conditioning system during service.

SUGGESTION:

- Stress the importance of capping or plugging fittings, valves, and connectors when opening the system to the atmosphere.
6. Use Information Sheet, Sections VI and VII to discuss problems caused by air and moisture entering an air-conditioning system.

SUGGESTIONS:

- Show filmstrips "Using the Equipment" and "Troubleshooting Problems" from the series *Automotive Air Conditioner Explained*.
 - Point out the various ways that air and moisture can enter the system:
 - a. Hooking up manifold-gauge set without purging air from hoses;
 - b. Failing to cap or seal a connection when disconnected;
 - c. Allowing air and moisture to enter the system after refrigerant escapes following the rupture of a component during a collision;
 - d. Improper evacuation of system.
 - Explain that it is impossible to avoid all contamination, but that proper service techniques (proper evacuation, replacement of receiver/drier, and connection of manifold-gauge set) minimize contamination.
7. Discuss and demonstrate Job Sheets #1 through #5.

(NOTE: It is recommended that the job sheets be performed in the sequence in which they appear in the unit.)

SUGGESTIONS:

- Demonstrate how to set up and connect a manifold-gauge set.
 - Arrange for a field trip to a dealership where students can observe an air-conditioning specialist service a system with a charging station.
8. Have students complete Job Sheets #1 through #5.

SUGGESTED ACTIVITIES

- G. Give test.
 - H. Critique test and discuss in class.
 - I. Complete appropriate section of competency profiles.
- III. Unit references
- A. *Automotive Technology 1985 Catalog*. Costa Mesa, California: Teaching Aids, Incorporated, 1985.
 - B. *Ford Training Handbook: Course 19000*, "How Air Conditioning Works." Vol. 65 S722, March, 1965.
 - C. *Heating and Air Conditioning Service: Student Guide*, "Unit 1: Test and Service a Basic Air Conditioning System." Tallahassee, Florida: Department of Education, Division of Vocational Education, April, 1983.
 - D. Seymour, A.T., R. Wright, and William Dean Conaster. *Automotive Air Conditioning Theory and Basic Service*. San Diego, California: National Automotive Service, Incorporated, 1970.

AIR-CONDITIONING SYSTEM
UNIT XIII

INFORMATION SHEET

I. Terms and definitions

- A. Vapor — A gas
- B. Boiling point — Temperature at which a liquid changes to vapor
- C. Evaporation — Conversion of liquid to vapor by adding heat
- D. Refrigerant — Substance that cools by evaporating and thereby absorbing heat from surrounding area
- E. Refrigeration — Removal of heat by evaporation; cooling
- F. R-12 — Refrigerant used in automotive air-conditioning systems

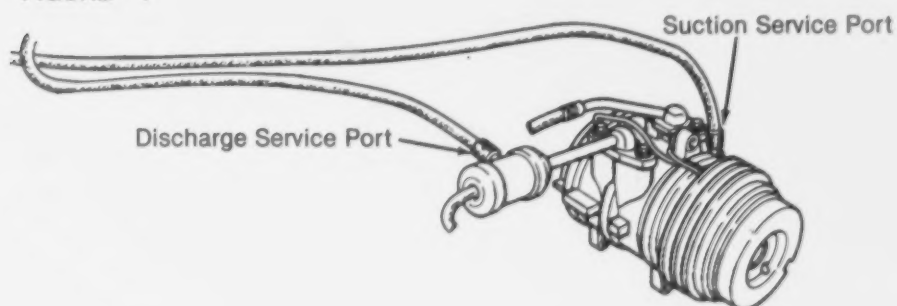
(NOTE: At atmospheric pressure, R-12 changes from liquid to vapor at -29.8°C or -21.6°F)
- G. Refrigerant oil — Special moisture-free oil refined especially for air-conditioning systems
- H. Charge — To add fresh refrigerant and refrigerant oil to an air-conditioning system; also the specific amount of refrigerant or refrigerant oil added to an air-conditioning system
- I. Discharge — To bleed some or all refrigerant from air-conditioning system by opening a valve or connection and allowing refrigerant to escape slowly
- J. Overcharge — To add too much refrigerant to air-conditioning system
- K. Evacuate — To remove air and moisture from air-conditioning system after it has been discharged
- L. Contaminant — Any foreign substance such as air, moisture, or dirt that enters an air-conditioning system
- M. Ambient air temperature — Temperature of air surrounding vehicle
- N. Ram air — Air forced through condenser coils by movement of vehicle and action of fan
- O. Desiccant — Drying agent used in air-conditioning system to absorb moisture
- P. Purge — To cleanse or rid of foreign matter or impurities

INFORMATION SHEET

- Q. Service ports — Fittings on suction and discharge sides of air-conditioning system; provide connections for testing and servicing system (Figure 1)

EXAMPLE:

FIGURE 1

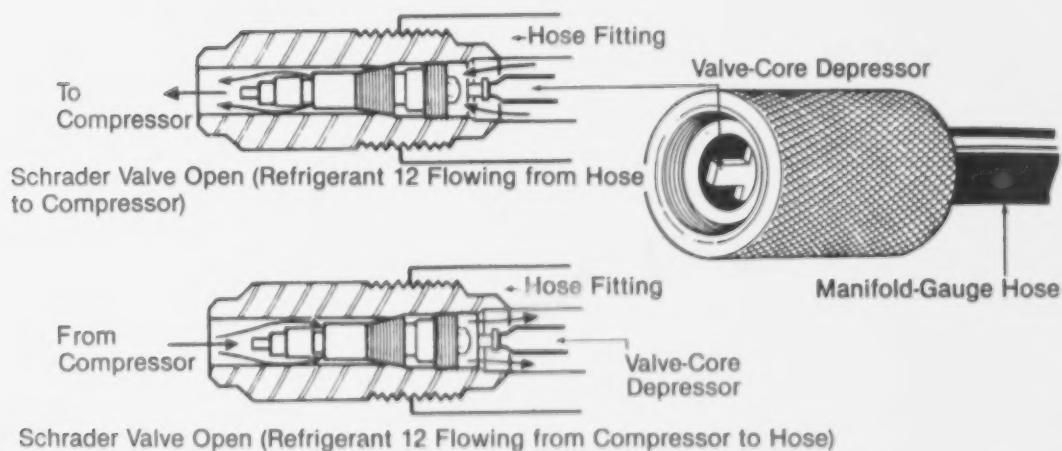


Used with permission of Chrysler Corporation.

- R. Schrader valve — Spring-loaded valve similar to a tire valve; located inside a service port (Figure 2)

EXAMPLE:

FIGURE 2

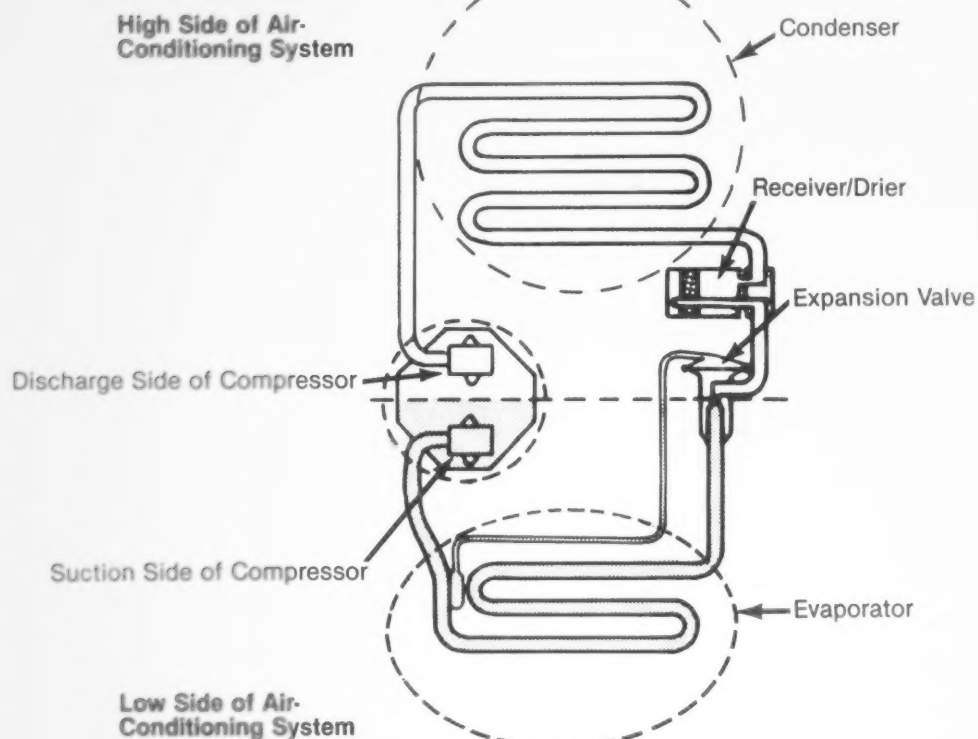


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INFORMATION SHEET

II. Components of a basic automotive air-conditioning system (Figure 3)

FIGURE 3

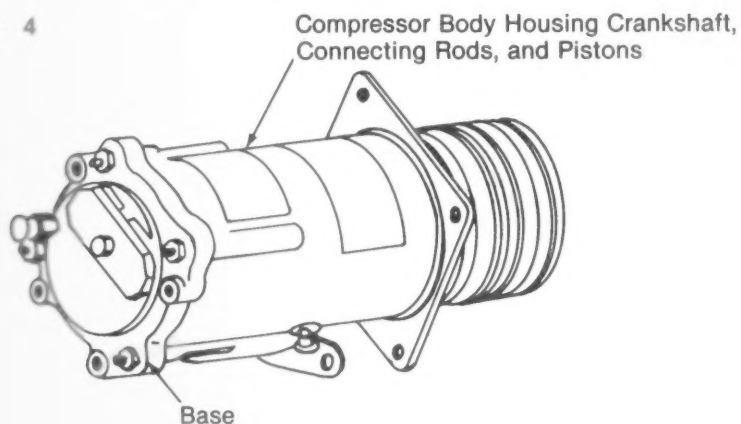


III. Descriptions and functions of air-conditioning system components

- A. **Compressor** — Device divided into two parts: the suction side and the discharge side; compresses low-pressure refrigerant vapor from evaporator into hot, high-pressure vapor (Figure 4)

EXAMPLE: Typical compressor assembly

FIGURE 4

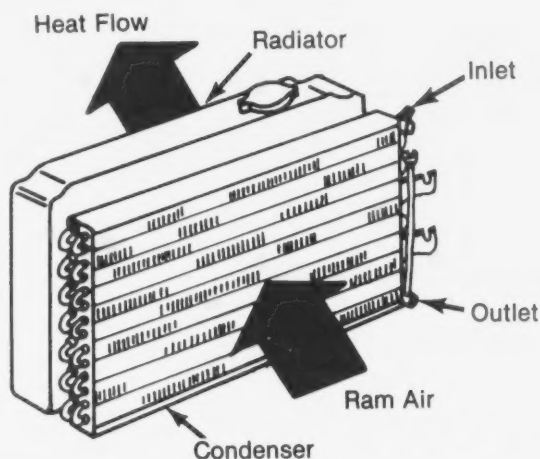


INFORMATION SHEET

- B. Condenser — Device located in front of radiator; cools hot, high-pressure refrigerant vapor from compressor, causing vapor to condense into high-pressure liquid refrigerant (Figure 5)

EXAMPLE:

FIGURE 5

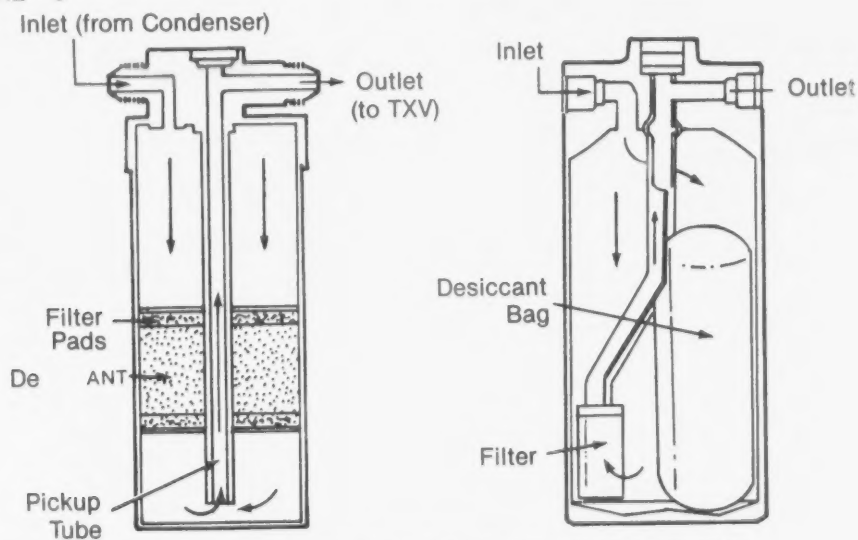


- C. Receiver/drier — Sealed container that contains a storage compartment for liquid refrigerant, a filter, and a desiccant bag; supplies liquid refrigerant to evaporator and absorbs moisture (Figure 6)

(NOTE: The receiver/drier should be discarded and replaced if the air-conditioning system has been open for a long time during body repairs.)

EXAMPLE: Typical receiver/drier assemblies

FIGURE 6



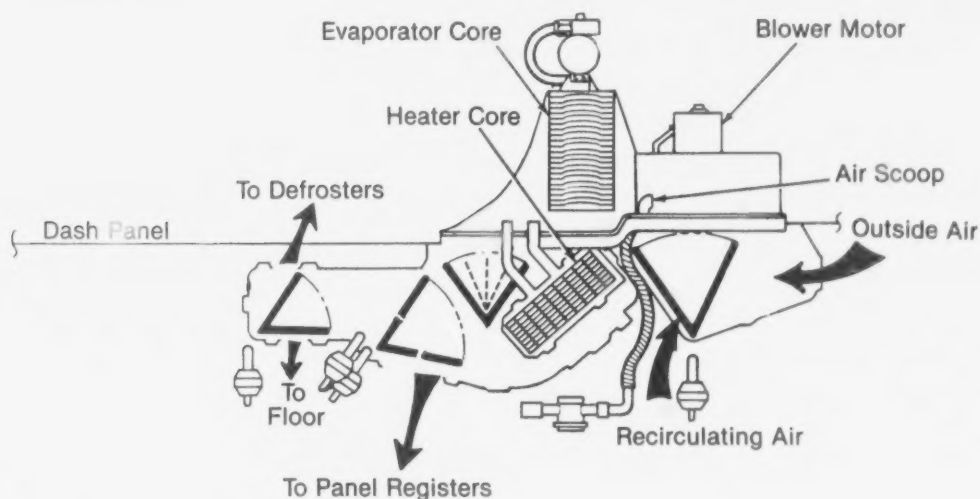
Used with permission of Florida Department of Education and Florida State University.

INFORMATION SHEET

- D. Expansion valve — Device located in circuit between condenser and evaporator; regulates flow of liquid refrigerant to evaporator
- E. Evaporator — Device that receives high-pressure liquid refrigerant from condenser and evaporates it, absorbing heat from surrounding air before it enters ventilation system to passenger compartment (Figure 7)

EXAMPLE: Location of evaporator in relation to ventilation system

FIGURE 7



Adapted with permission of Ford Parts and Service Division, Training and Publications Department.

IV. Safety rules for servicing the air-conditioning system

- A. Never service an air-conditioning system until you completely understand air-conditioning service and know how to use the proper equipment for the job
- B. Always wear eye protection when servicing *any* component of the system
- C. Never let escaping refrigerant contact your skin or eyes

(NOTE: Escaping refrigerant evaporates so quickly that it freezes anything it touches, including eyes and skin.)

- D. Never discharge refrigerant into a room where an open flame is present

(NOTE: Normally, refrigerant is not poisonous, but it turns into a very poisonous gas when it contacts an open flame.)

INFORMATION SHEET

- E. Always discharge refrigerant into shop's exhaust system or into open air

(NOTE: Large quantities of refrigerant vapor in a small, poorly ventilated area can displace the air and cause suffocation.)

- F. Never heat a container of refrigerant when charging a system

(NOTE: Cans of refrigerant are under pressure; heating will cause the can to explode.)

- G. When steam cleaning or welding, never apply any form of heat to any component of air-conditioning system

(NOTE: Components of the air-conditioning system are under pressure. Heat could increase the pressure and cause an explosion.)

- H. Avoid inhaling fumes from torch-type leak detector

(NOTE: The torch flame converts the refrigerant to a very poisonous gas.)

V. Guidelines for protecting the air-conditioning system during service

- A. Before servicing the system, study the service manual for particular make and model vehicle to be worked on

- B. Immediately cap or plug fittings, valves, and connectors when opening system to atmosphere

(NOTE: Sealing or capping the fittings, valves, and connectors helps keep contaminants such as air, moisture, and dirt from entering the system.)

- C. Be sure to charge the system only with refrigerant specifically made for automotive air-conditioning systems

(NOTE: Do not use R-22, which is made for room air conditioners.)

- D. Always evacuate the system after discharging it

(NOTE: Evacuation removes all air and moisture from the system. Air and moisture can cause malfunction or permanent damage to the system.)

VI. Problems caused by air in an air-conditioning system

(NOTE: All of the problems listed below can be avoided by proper evacuation of the system after it has been opened.)

- A. High compressor-discharge pressures

- B. System performance loss

INFORMATION SHEET

C. Compressor-oil oxidation

(NOTE: Exposing compressor oil to the oxygen in air causes the oil to change into gum and varnish.)

VII. Problems caused by moisture in an air-conditioning system

A. Expansion-valve malfunction

(NOTE: Moisture freezing as it passes through the expansion valve causes the valve to expand and malfunction.)

B. Acid damage

(NOTE: Moisture can react with refrigerant to form an acid that is destructive to air-conditioning components.)

AIR-CONDITIONING SYSTEM
UNIT XIIIJOB SHEET #1 — DISCHARGE AND EVACUATE AN AUTOMOTIVE
AIR-CONDITIONING SYSTEM

I. Equipment and materials

- A. Basic hand-tool set
- B. Manifold-gauge set
- C. Service manual for vehicle being worked on
- D. Refrigerant oil
- E. Flexible hose and funnel
- F. Suction gun
- G. Refrigerant oil specified by manufacturer
- H. Container for collecting refrigerant oil

(NOTE: An empty coffee can with a plastic lid makes a good oil collection container. Make slits in the plastic lid in the shape of a "Y" or "X" through which to insert the hose.)

- I. Vacuum pump
- J. Clean shop towels or rags
- K. Fender and seat covers
- L. Eye protection

II. Procedure

- A. Put on eye protection
- B. Prepare system and manifold-gauge set for installation
 - 1. Start engine and run air conditioner at *maximum* cool, *high* fan for about five minutes to circulate refrigerant and oil

CAUTION

Observe all safety precautions that apply to starting and running a vehicle. Be sure to have adequate ventilation, apply the hand brake, cover the seats, and put the vehicle in PARK or NEUTRAL.

JOB SHEET #1

2. Shut off engine
3. Open hood and install fender covers
4. Unscrew low-side (suction-side) and high-side (discharge-side) service port protective caps

CAUTION

Remove protective caps *very slowly* because some refrigerant may have leaked past the service port.

5. Close all valves on manifold-gauge set

CAUTION

Failure to close the manifold-gauge valves may cause the gauges to burst.

C. Install manifold gauge set

1. Connect high-pressure (discharge-side) gauge hose to high-pressure service port; hand tighten

(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including eyes and skin.

2. Connect low-pressure (suction-side) gauge hose to low-pressure service port; hand tighten

(NOTE: With Schrader-type service valves, the gauges will show the system pressure with the manifold-gauge valves closed.)

D. Open hand-operated service valves on compressor if it is so equipped

1. Remove covers around valve stems with your fingers or pliers
2. Use service valve wrench to turn service valves clockwise two full turns from back-seated position to midposition

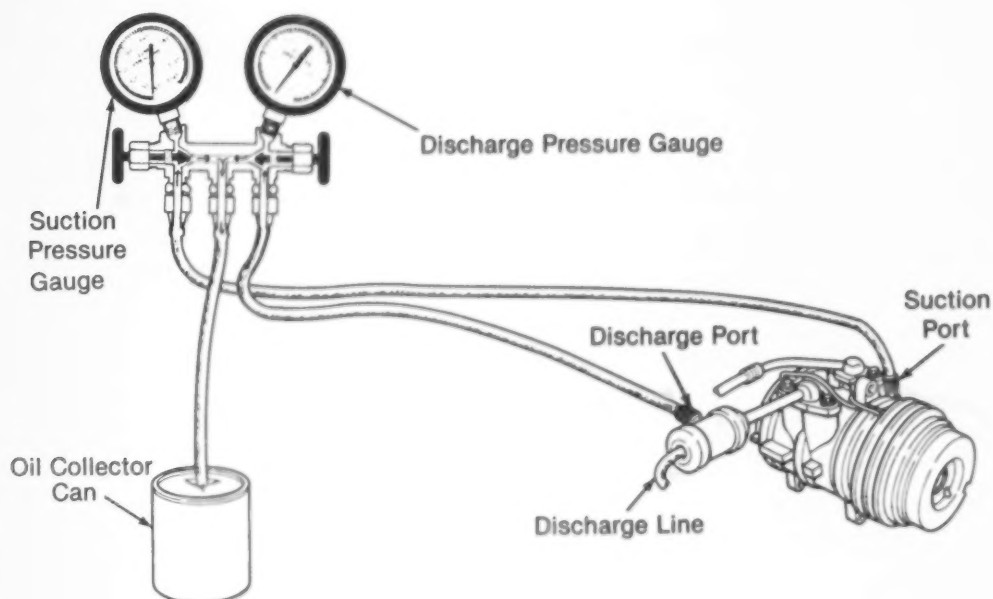
E. Discharge the system

(NOTE: If the manifold gauges indicate *any* pressure, you must discharge the system. If the gauges read ZERO, proceed to step G.)

JOB SHEET #1

1. Connect long hose to manifold-gauge set, and run other end of hose to oil collector can as shown in Figure 8; finger tighten connection at manifold-gauge set

FIGURE 8



Adapted with permission of the Chrysler Corporation.

2. Slowly open low-pressure manifold-gauge valve to discharge refrigerant

(NOTE: Opening the manifold-gauge valve too fast allows refrigerant oil to escape. If oil starts to come out along with the refrigerant, close the low-pressure manifold gauge slightly to slow the flow of refrigerant and to stop the loss of too much refrigerant oil from the system.)

CAUTION

Escaping refrigerant will freeze anything it contacts—including eyes and skin.

3. When gauge readings are at ZERO, close low-pressure manifold-gauge valve
4. Remove center hose of manifold-gauge set from collection can
5. Measure and note amount of refrigerant oil in collection can

JOB SHEET #1

(NOTE: The exact amount of refrigerant oil lost during discharging must be replaced in system with clean refrigerant oil of the correct specifications.)

F. Check compressor oil level

(NOTE: It is important to check the compressor oil level whenever refrigerant is discharged from the system to make sure that there is enough lubrication in the system.)

1. Remove fill plug on side of compressor
2. Put oil dipstick through opening until it reaches bottom of compressor
3. Remove dipstick and compare reading to manufacturer's specifications
4. Add or remove refrigerant oil through fill plug hole as necessary

(NOTE: Refer to service manual for refrigerant oil specifications.)

- a. To add oil, use a flexible hose and a funnel
 - b. To remove excess oil, use a suction gun
5. Recheck oil level with dipstick
 6. Replace fill plug

(NOTE: Refrigerant oil is moisture-free and wax-free and contains no detergents. It should not be left open to the air any longer than necessary because it will absorb moisture.)

G. Evacuate the system

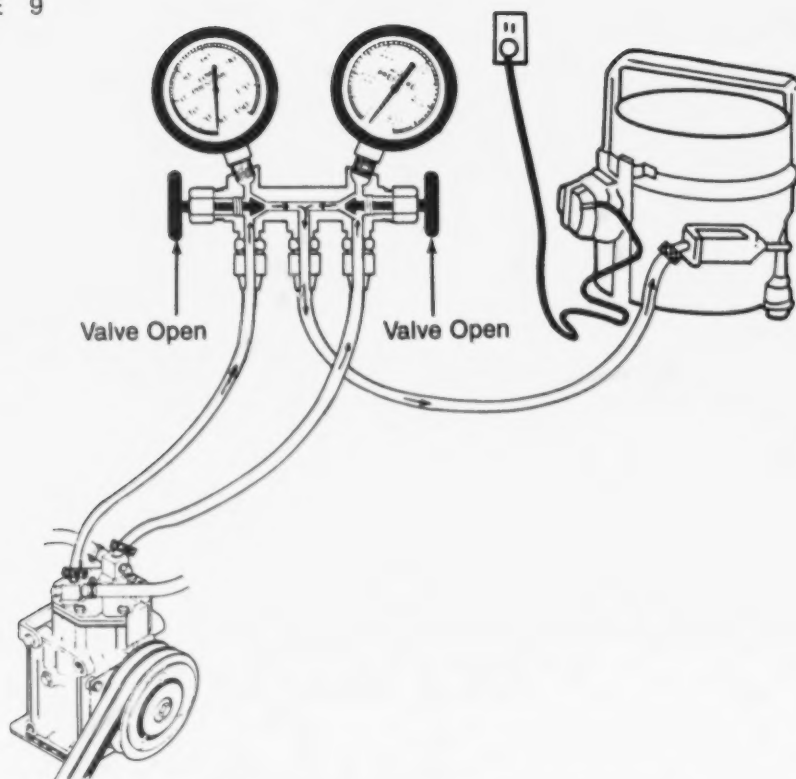
1. Connect capacity-tested vacuum pump to center hose of manifold-gauge set; hand tighten coupling (Figure 9)

CAUTION

Be sure to *hand tighten* the vacuum pump coupling; overtightening may damage the seals.

JOB SHEET #1

FIGURE 9



Used with permission of Florida Department of Education and Florida State University.

2. Start vacuum pump
3. Slowly open both low-pressure and high-pressure manifold-gauge valves
4. Run vacuum pump until low-pressure manifold gauge shows *at least* 29 inches of vacuum (or as specified by manufacturer)
5. Continue to run pump until all moisture has been removed from system
 (NOTE: Evacuation may take as little as thirty minutes or as long as over-night, depending on how much moisture is in the system. If the system has been open for more than three or four hours, an overnight evacuation is recommended.)
6. Close manifold-gauge valves and shut off vacuum pump

JOB SHEET #1

7. Check manifold-gauge readings: if readings stay the same (below 29 inches) for about five minutes, it is a good indication that there is no leak in the system; if reading decreases, there is probably a leak in the system

(NOTE: If there is a suspected leak, leak-testing should be performed. See Job Sheet #5.)

I. Return vehicle to normal operation

(NOTE: If vehicle needs to be charged, exit this job sheet and complete Job Sheet #4 at this time.)

1. Return air-conditioning controls and fan to their OFF positions
2. Set both hand-operated service valves (if so equipped) in back-seated position by turning their valve stems counterclockwise until valves are seated
3. Disconnect manifold-gauge set from system

CAUTION

The system has been in operation and the high-pressure side is hot. Be careful not to burn yourself. The high-side hose will be under pressure. You may want to use a rag to remove it.

4. Replace service port protective caps and service valve stem covers; tighten to seal
 5. Remove seat covers and fender covers and close hood
- J. Clean work area and return equipment and materials to proper storage

AIR-CONDITIONING SYSTEM
UNIT XIII

JOB SHEET #2 — REMOVE AND REPLACE A CONDENSER

I. Equipment and materials

- A. Service manual for vehicle being worked on
- B. Replacement condenser
- C. Basic hand-tool set
- D. Line wrench
- E. Flare-nut wrench set
- F. Refrigerant oil
- G. Manifold-gauge set
- H. O-ring assortment
- I. Masking tape
- J. Fender and seat covers
- K. Eye protection
- L. Flexible hose and funnel for adding refrigerant oil

II. Procedure

(NOTE: Since the location of the condenser and the way it is attached vary from vehicle to vehicle, you should consult the vehicle service manual for specific procedures. The following steps, however, are typical procedures.)

- A. Protect vehicle with fender covers and put on eye protection
- B. Connect manifold-gauge set to air-conditioning system
 - 1. Close all valves on manifold-gauge set
 - 2. Check manifold-gauge hoses to make sure that rubber sealing gasket is in place and in good condition and that depressor pin is not missing, bent, or broken
 - 3. Connect high-pressure (discharge-side) manifold-gauge hose to discharge service port; hand tighten

JOB SHEET #2

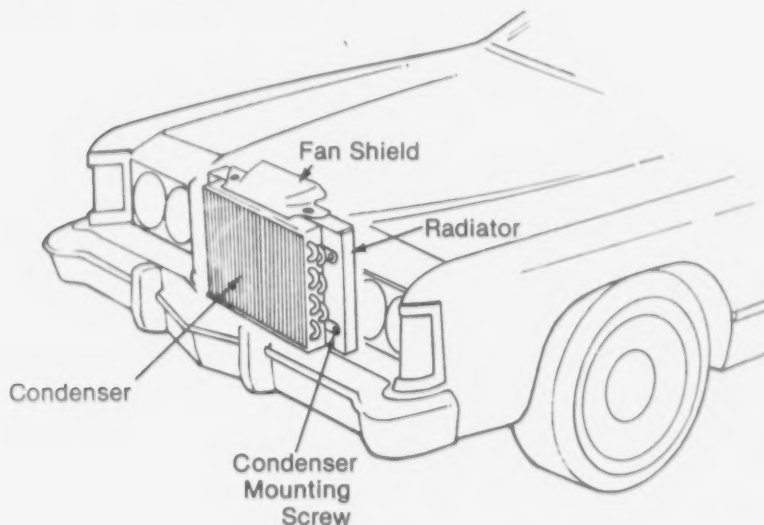
(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including skin and eyes.

4. Connect low-pressure (suction-side) manifold-gauge hose to suction service port; hand tighten
- C. Open hand-operated service valves on compressor if it is so equipped
- D. Discharge air-conditioning system and check compressor oil level (Job Sheet #1)
- E. Remove fan shield and/or radiator, if necessary, to gain access to condenser (Figure 10)

FIGURE 10: Typical location of condenser



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- F. Use line wrench to disconnect inlet and outlet lines from condenser
- G. Temporarily cap or plug ends of lines to prevent air, moisture, and dirt from entering system
- H. Remove condenser mounting screws; stick to a piece of masking tape and set aside where they will not get lost or damaged

JOB SHEET #2

- I. Remove condenser from vehicle
- J. Add 1 ounce of new refrigerant oil to replacement condenser
- K. Position replacement condenser correctly on vehicle
- L. Check service manual to determine whether new o-rings need to be installed on condenser
- M. Install new o-rings on condenser if necessary, making sure to dip them in clean refrigerant oil before installation

(NOTE: Dipping o-rings in refrigerant oil lubricates the rings to prevent damage and to help ensure a tight seal.)
- N. Install condenser mounting screws
- O. Lubricate inlet and outlet lines to condenser and then install them
- P. Reinstall fan shield and/or radiator and any other parts that were removed to gain access to condenser
- Q. Evacuate system (Job Sheet #1)
- R. Charge system (Job Sheet #4)
- S. Clean work area and return equipment and materials to proper storage

AIR-CONDITIONING SYSTEM
UNIT XIII

JOB SHEET #3 — REMOVE AND REPLACE A RECEIVER/DRIER

I. Equipment and materials

A. Service manual for vehicle being worked on

B. Replacement receiver/drier

(NOTE: On some General Motors models, the filter pads and desiccant in the receiver/drier can be replaced. This job sheet, however, covers the nonserviceable type of receiver/drier that is usually found in a basic automotive air-conditioning system.)

C. Replacement flexible inlet and outlet hoses and hose clamps (if applicable for receiver/drier model)

D. Basic hand-tool set

E. Line wrench

F. Flare-nut wrench set

G. Knife for removing flexible hoses if applicable

H. Refrigerant oil

I. Manifold-gauge set

J. Masking tape

K. Fender and seat covers

L. Eye protection

M. Flexible hose and funnel for adding refrigerant oil

II. Procedure

A. Protect vehicle with fender covers and put on eye protection

B. Connect manifold-gauge set to air-conditioning system

1. Close all valves on manifold-gauge set

2. Check manifold-gauge hoses to make sure that rubber sealing gasket is in place and in good condition and that depressor pin is not missing, bent, or broken

JOB SHEET #3

3. Connect high-pressure (discharge-side) manifold-gauge hose to discharge service port; hand tighten

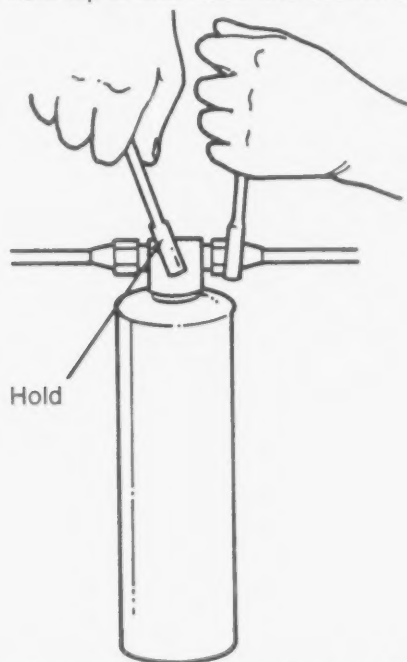
(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including skin and eyes.

4. Connect low-pressure (suction-side) manifold-gauge hose to suction service port; hand tighten
- C. Open hand-operated service valves on compressor if it is so equipped
 - D. Discharge air-conditioning system and check compressor oil level (Job Sheet #1)
 - E. Remove inlet and outlet lines
 1. To prevent damage to either receiver/drier or lines, use an open-end wrench to hold top of unit and a line wrench to loosen fittings (Figure 11)

FIGURE 11



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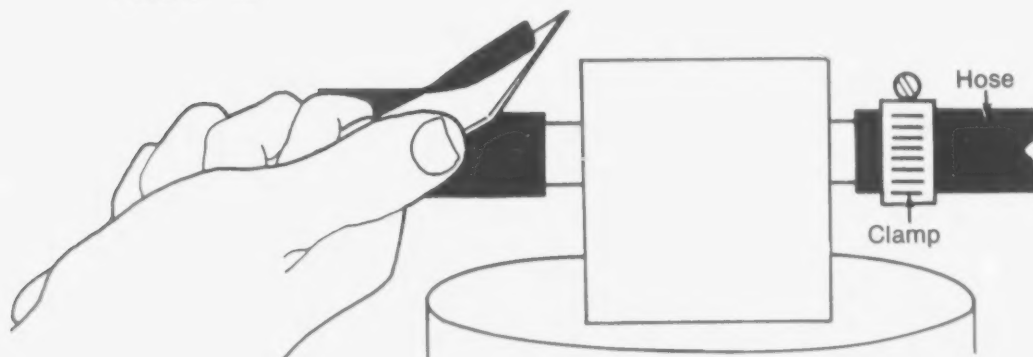
JOB SHEET #3

2. If receiver/drier is connected to air-conditioning system with flexible hoses, slice the hoses to remove (Figure 12)

CAUTION

Do not let the cutting instrument touch the barbs of the fitting.

FIGURE 12



Used with permission of Florida Department of Education and Florida State University.

- F. Remove mounting bracket bolts; stick to a piece of masking tape and set aside where they will not get lost or damaged

- G. Remove receiver/drier from vehicle

(NOTE: Note the position of the inlet and outlet lines so that you can install the new receiver/drier properly.)

CAUTION

To prevent moisture from entering the drier, do not unseal the new receiver/drier until you are ready to install it.

- H. Unseal the new receiver/drier and add 1 ounce of new refrigerant oil

- I. Position new receiver/drier correctly on vehicle

- J. Install mounting bracket bolts

- K. Lubricate line fittings with new refrigerant oil and position the lines

- L. Install and tighten the nuts, using two wrenches as during removal

(NOTE: If flexible hoses were used, install new hoses and hose clamps.)

JOB SHEET #3

- M. Evacuate system (Job Sheet #1)
- N. Charge system (Job Sheet #4)
- O. Clean work area and return equipment and materials to proper storage

AIR-CONDITIONING SYSTEM
UNIT XIII

JOB SHEET #4 — CHARGE AN AUTOMOTIVE AIR-CONDITIONING SYSTEM

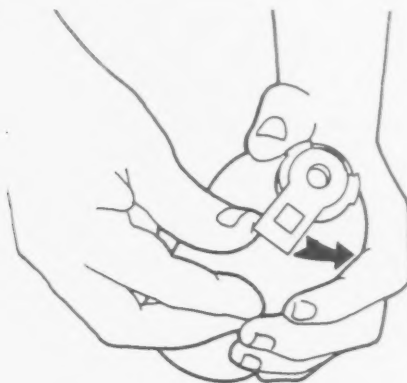
I. Equipment and materials

- A. Basic hand-tool set
- B. Manifold-gauge set
- C. Service manual for vehicle being worked on
- D. Oil dipstick
- E. Refrigerant oil specified by manufacturer
- F. Long hose and connector
- G. Clean shop towels or rags
- H. Fender and seat covers
- I. Eye protection
- J. Cans of R-12
- K. Refrigerant supply valve (can valve) and its adapter
- L. Pan for warm water

II. Procedure

- A. Put on eye protection
- B. Prepare manifold-gauge set and air-conditioning system for charging
 - 1. Install adapter on R-12 can, making sure that lips of adapter are under lips of container as shown in Figure 13; lock adapter in place

FIGURE 13

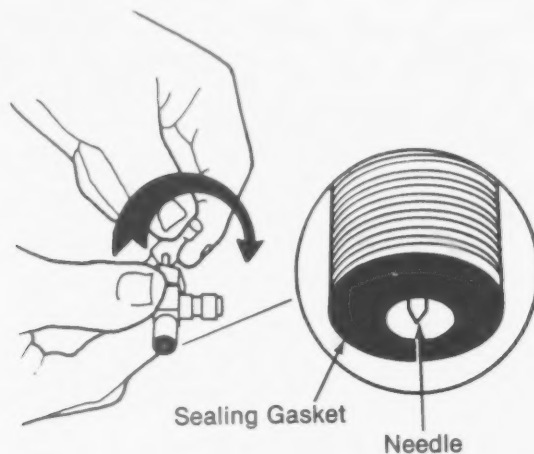


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JOB SHEET #4

2. Back hand-control valve of refrigerant supply valve all the way out to make sure that sealing gasket in needle end of valve assembly is in place (Figure 14)

FIGURE 14



3. Put a drop of refrigerant oil on sealing gasket to help get a good seal
4. Thread valve assembly into can adapter until seal seats lightly on top of can (Figure 15)

CAUTION

The can is under pressure. Do not force the valve assembly into the top of the can.

FIGURE 15



Figures 15 and 16 used with permission of Florida Department of Education and Florida State University.

JOB SHEET #4

5. Connect manifold-gauge set to air-conditioning system

- a. Close all valves on manifold-gauge set
- b. Check manifold-gauge hoses to make sure that rubber sealing gasket is in place and in good condition and that depressor pin is not missing, bent, or broken
- c. Connect high-pressure (discharge-side) manifold-gauge hose to discharge service port; hand tighten

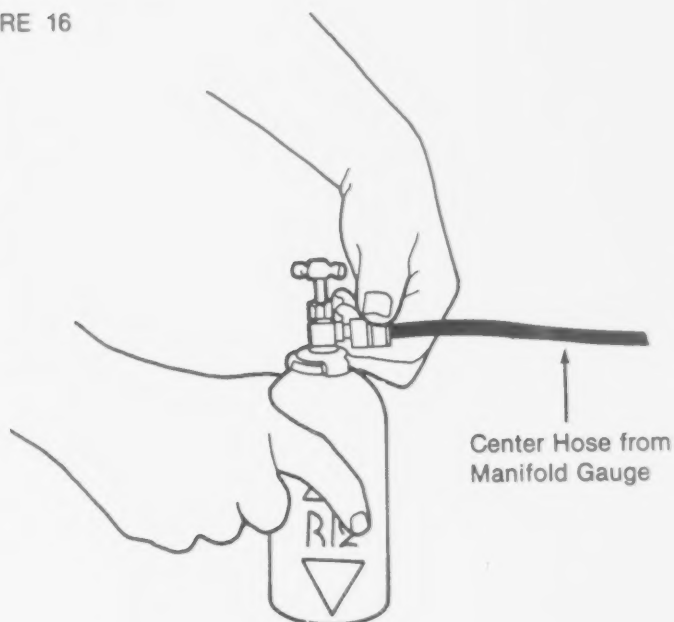
(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including skin and eyes.

- d. Connect low-pressure (suction-side) manifold-gauge hose to suction service port; hand tighten
6. Connect center hose of manifold-gauge set to refrigerant supply valve (Figure 16)

FIGURE 16



Used with permission of Florida Department of Education and Florida State University.

JOB SHEET #4

7. Close hand-control valve all the way, causing needle in valve to puncture a small hole in refrigerant can
8. Open hand-control valve all the way to release R-12 into center hose of manifold-gauge set
9. Purge center hose of air

(NOTE: Purging is done to prevent air and moisture trapped in the hose from being forced into the system when the manifold-gauge valve is opened.)

- a. Slightly loosen center hose connection at manifold-gauge set to force out air trapped in hose
- b. When refrigerant starts to escape, tighten center hose connection by hand

C. Charge the system

1. Check vehicle manufacturer's specifications to determine how much refrigerant the air-conditioning system requires

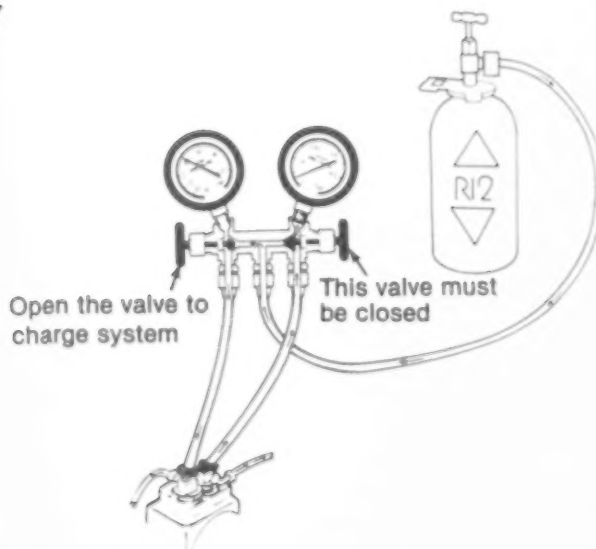
(NOTE: Check the net weight on the refrigerant can. Most cans today contain 14 ounces of refrigerant. Sixteen ounces equal 1 pound.)

2. Slowly turn *low-pressure* (suction-side) manifold-gauge valve until it is fully open to allow R-12 gas to enter system (Figure 17)

CAUTION

Never open the high-side manifold gauge valve while you are charging the system.

FIGURE 17



Used with permission of Florida Department of Education and Florida State University.

JOB SHEET #4

3. Determine whether can is empty by tapping on the bottom of it; an empty can will sound hollow
4. When can is empty, close low-pressure manifold-gauge valve
5. Replace empty can with new can, following all procedures used to install first can

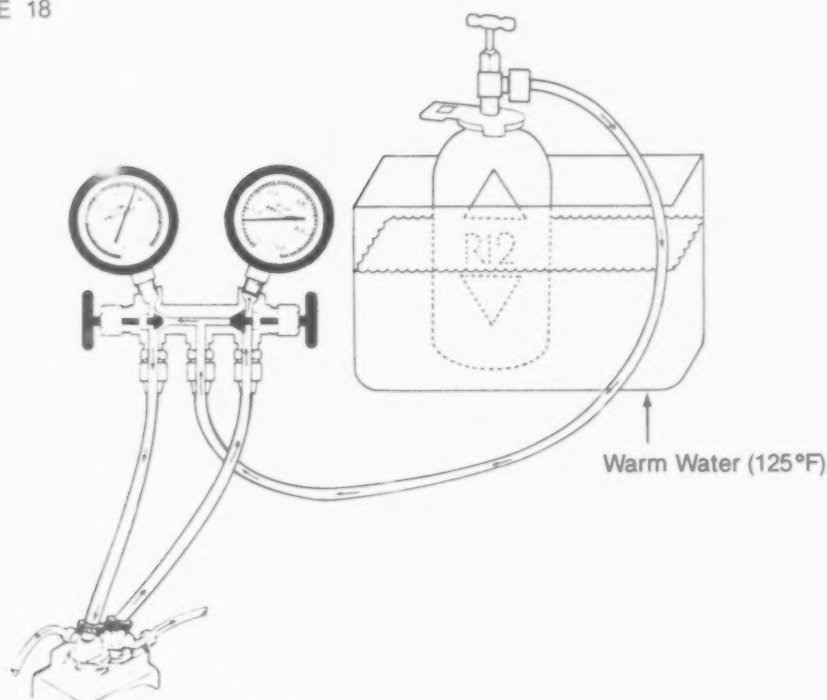
(NOTE: You *must* purge the hose each time you change cans.)

6. Continue replacing cans until you have added the proper amount of refrigerant; if you have difficulty forcing additional cans of refrigerant into the system, try one of the following procedures:

a. Warm water procedure (Figure 18)

- 1) Fill pan with warm—*not hot*—water, 125°F
- 2) Immerse R-12 can in warm water to raise temperature and pressure in can and force refrigerant into system

FIGURE 18



Used with permission of Florida Department of Education and Florida State University.

JOB SHEET #4

b. Procedure for using compressor to draw refrigerant into system

- 1) Start vehicle engine and adjust it to 1500 rpm by setting carburetor's fast idle cam on highest position, opening throttle slightly, and raising cam link

CAUTION

Observe all safety precautions that apply to starting and running a vehicle. Be sure to have adequate ventilation, apply the hand brake, cover the seats, and put vehicle in PARK or NEUTRAL.

- 2) Hold link in raised position and release accelerator
- 3) Adjust air-conditioner controls to *maximum* cooling and *high* speed
- 4) Slowly open *low-pressure* manifold-gauge valve to allow the difference in pressure between the R-12 can and suction side of compressor to draw refrigerant into system

CAUTION

Never open the high-side manifold-gauge valve while you are charging the system. *Never* turn the can upside down after you have started the vehicle engine. Refrigerant forced into the low-pressure side of the compressor would seriously damage the vehicle.

- D. After system is fully charged, close low-side manifold gauge valve
- E. Close R-12 supply valve
- F. Set hand-operated service valves in back-seated position if compressor is so equipped
- G. Disconnect manifold-gauge set and return engine idle and vehicle to normal operation
- H. Clean work area and return equipment and materials to proper storage

AIR-CONDITIONING SYSTEM
UNIT XIII

JOB SHEET #5 — LEAK-TEST AN AUTOMOTIVE AIR-CONDITIONING SYSTEM

I. Equipment and materials

- A. Service manual for vehicle being worked on
- B. Inspection report form provided by instructor
- C. Pen or pencil for recording results
- D. Basic hand-tool set
- E. Service valve wrench
- F. Manifold-gauge set
- G. Torch-type leak detector
- H. Electronic leak detector
- I. Fender covers
- J. Eye protection
- K. Shop towels or rags

II. Procedure for using a torch-type leak detector

(NOTE: The procedures for operating torch-type leak detectors vary according to the product. You should follow the manufacturer's instructions. The following steps, however, are typical procedures.)

- A. Put on eye protection
- B. Prepare system for leak-testing
 - 1. Open hood and protect vehicle with fender covers
 - 2. Visually inspect system for signs of leakage
 - 3. With engine OFF, connect manifold-gauge set to system
 - a. Close all valves on manifold-gauge set
 - b. Check manifold-gauge hoses to make sure that rubber sealing gasket is in place and in good condition and that the depressor pin is not missing, bent, or broken

JOB SHEET #5

- c. Connect high-pressure (discharge-side) manifold-gauge hose to discharge service port; hand tighten

(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including skin and eyes.

- d. Connect low-pressure (suction-side) manifold-gauge hose to suction service port; hand tighten

(NOTE: The center hose of the manifold-gauge set does not need to be connected at this time.)

4. If compressor has hand-operated service valves, set them to midposition (service position)

- a. Remove cover around service valve stems with your fingers or pliers
- b. Use service valve wrench to turn both valve stems clockwise two full turns from back-seated position

5. Observe pressure reading on either gauge

(NOTE: With the manifold-gauge set connected to the system, after the engine has been off for ten to twenty minutes, both gauges will read the same.)

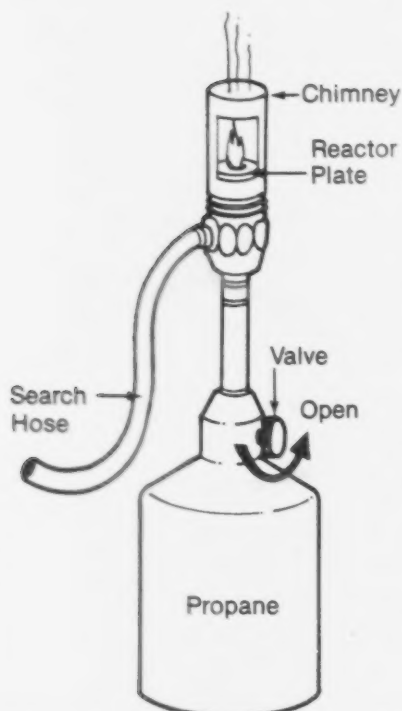
6. Make sure that there is enough refrigerant in system (at least 50 psi gauge pressure) to perform leak test; if refrigerant is too low, charge system, following procedures outlined in Job Sheet #4

C. Prepare leak detector

1. Open valve on leak detector just enough to release gas into burner (See Figure 19)

JOB SHEET #5

FIGURE 19



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2. Light gas and adjust flame until it burns about $\frac{1}{2}$ inch above reactor plate inside burner (See Figure 19)
3. Allow flame to burn until reactor plate in burner turns cherry red
4. Adjust flame as low as possible, keeping reactor plate cherry red
(NOTE: The lower the flame, the greater the detector's sensitivity.)

D. Check for leaks in air-conditioning system

CAUTION

Do not use lighted detector in any place where explosive gases, dust, or vapors are present.

1. Keeping tank as vertical as possible, move open end of search hose under and around all lines and hose connections, under front of compressor, and into evaporator drain hose to check for leakage at sight glass (See Figure 21 for areas to check.)

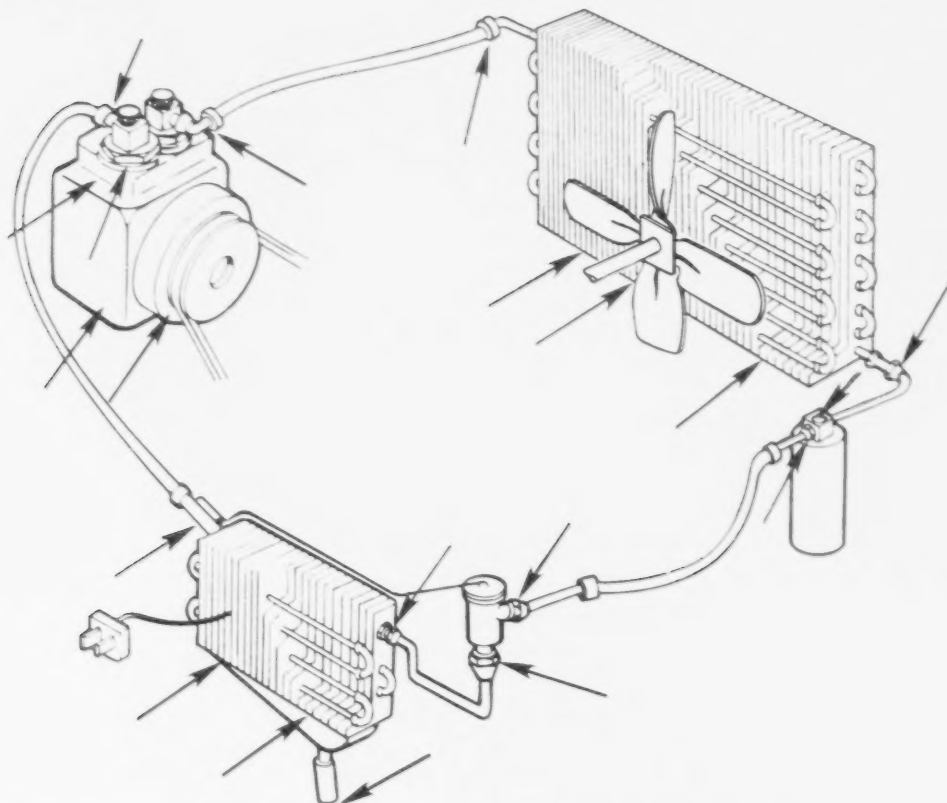
(NOTE: Refrigerant 12 is heavier than air and will move downward from the leak, so always place the search hose *under* parts being checked. Be careful not to block the flow of air into the hose.)

JOB SHEET #5

CAUTION

Do not breathe the fumes that come from the torch when a leak is located. They are very poisonous.

FIGURE 20



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2. Note flame color to determine whether there are leaks and to evaluate size of leak; use Table 1 on the following page to help you evaluate the results

CAUTION

The larger the leak, the more poisonous phosgene gas released.

JOB SHEET #5

TABLE 1

Flame color guide

Flame color	Leak size
Pale blue	Normal flame color; no leak
Pale yellow at edges	Very small leak
Yellow-green	Small leak
Green-blue	Large leak
Violet	Very large leak, possibly large enough to put out flame

E. If you find any leaks, record them on your inspection report form and check with your instructor about repair procedures

F. Remove manifold-gauge set and fender covers from vehicle and close hood

G. Clean work area and return equipment and materials to proper storage

III. Procedure for using an electronic leak detector

(NOTE: The procedures for operating an electronic leak detector vary according to the product. Follow the manufacturer's operating instructions. The following steps, however, are typical procedures.)

A. Put on eye protection

B. Prepare system for leak testing

1. Open hood and protect vehicle with fender covers
2. Visually inspect system for signs of leakage
3. With engine OFF, connect manifold-gauge set to system
 - a. Close all valves on manifold-gauge set
 - b. Check manifold-gauge hoses to make sure that rubber sealing gasket is in place and in good condition and that the depressor pin is not missing, bent, or broken
 - c. Connect high-pressure (discharge-side) manifold-gauge hose to discharge service port; hand tighten

(NOTE: Only hand tighten the hose couplings; overtightening may damage the service ports.)

CAUTION

If refrigerant escapes, use a rag or shop towel to keep it from spraying on your fingers. Escaping refrigerant will freeze anything it contacts—including skin and eyes.

JOB SHEET #5

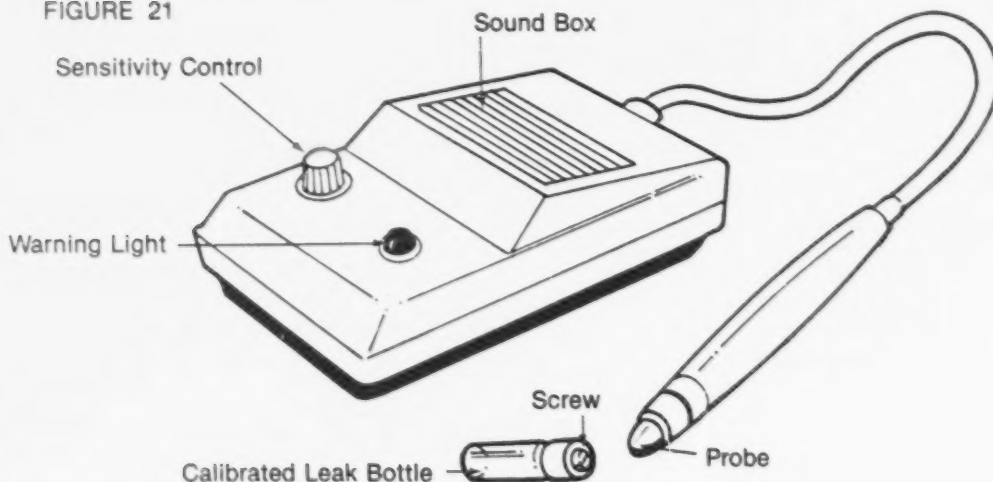
- d. Connect low-pressure (suction-side) manifold-gauge hose to suction service port; hand tighten

(NOTE: The center hose of the manifold-gauge set does not need to be connected at this time.)

C. Prepare leak detector and check its sensitivity

1. Turn detector switch to ON position
2. Allow detector to warm up and then adjust sensitivity control (Figure 21) until you hear a steady ticking sound

FIGURE 21



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3. Back off sensitivity control until ticking stops
4. Remove screw from calibrated leak bottle (Figure 21) to allow a small amount of refrigerant to leak out
5. Move flexible probe of leak detector toward leak bottle: ticking should get faster and change to a squeal when probe is held directly in contact with calibrated orifice; warning light should come on
6. Move probe away from bottle: squeal should weaken, change to steady ticking, and then stop; warning light should go out
7. Replace screw in leak bottle and tighten

JOB SHEET #5

D. Check for leaks in the system

1. Move flexible probe under and around all lines, hoses, connections, compressor, condenser, and evaporator (See Figure 20 for areas to check.)

(NOTE: Refrigerant 12 is heavier than air and will move downward from the leak, so be sure to hold the probe *under* the component being checked.)

2. Listen for a change in the ticking sound of detector: the larger the leak, the more the ticking will turn to a squeal
- E. If you find any leaks, record them on your inspection report form and check with your instructor about repair procedures
- F. Remove manifold-gauge set and fender covers from vehicle and close hood
- G. Clean work area and return equipment and materials to proper storage

AIR-CONDITIONING SYSTEM UNIT XIII

TEST

NAME _____

SCORE _____

1. Match to their correct definitions terms associated with automotive air-conditioning systems. Write the correct numbers in the blanks.

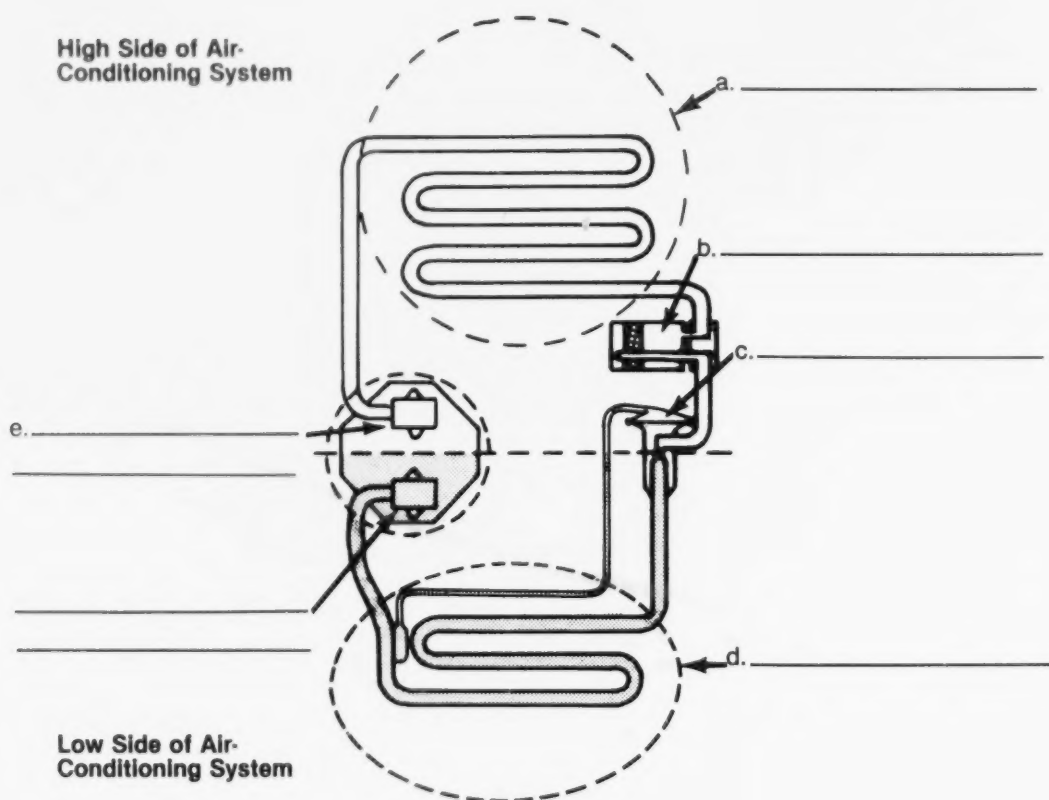
- | | |
|--|-----------------------------|
| _____a. Temperature of air surrounding vehicle | 1. Vapor |
| _____b. To remove air and moisture from air-conditioning system after it has been discharged | 2. Boiling point |
| _____c. Temperature at which a liquid changes to vapor | 3. Evaporation |
| _____d. Spring-loaded valve similar to a tire valve; located inside a service port | 4. Refrigerant |
| _____e. A gas | 5. Refrigeration |
| _____f. To bleed some or all refrigerant from air-conditioning system by opening a valve or connection and allowing refrigerant to escape slowly | 6. R-12 |
| _____g. Any foreign substance such as air, moisture, or dirt that enters an air-conditioning system | 7. Refrigerant oil |
| _____h. Air forced through condenser coils by movement of vehicle and action of fan | 8. Charge |
| _____i. To add too much refrigerant to air-conditioning system | 9. Discharge |
| _____j. Drying agent used in air-conditioning system to absorb moisture | 10. Overcharge |
| _____k. Removal of heat by evaporation; cooling | 11. Evacuate |
| _____l. To add fresh refrigerant and refrigerant oil to an air-conditioning system; also the specific amount of refrigerant or refrigerant oil added to an air-conditioning system | 12. Contaminant |
| _____m. Conversion of liquid to vapor by adding heat | 13. Ambient air temperature |
| _____n. Substance that cools by evaporating and thereby absorbing heat from surrounding area | 14. Ram air |
| | 15. Service ports |
| | 16. Schrader valve |
| | 17. Desiccant |
| | 18. Purge |

TEST

- _____o. Refrigerant used in automotive air-conditioning systems
 - _____p. Special moisture-free oil refined especially for air-conditioning systems
 - _____q. Fittings on suction and discharge sides of air-conditioning system; provide connections for testing and servicing system
 - _____r. To cleanse or rid of foreign matter or impurities
2. Identify the components of the basic automotive air-conditioning system illustrated below. Write the correct names in the blanks.

Discharge side of compressor
Suction side of compressor
Condenser

Evaporator
Expansion valve
Receiver/drier



TEST

3. Match the following air-conditioning system components to their correct descriptions/ functions. Write the correct numbers in the blanks.

- _____a. Device located in front of radiator; cools hot, high-pressure refrigerant vapor from compressor, causing vapor to condense into high-pressure liquid refrigerant
- _____b. Sealed container that contains a storage compartment for liquid refrigerant, a filter, and a desiccant bag; supplies liquid refrigerant to evaporator and absorbs moisture
- _____c. Device that receives high-pressure liquid refrigerant from condenser and evaporates it, absorbing heat from surrounding air before it enters ventilation system to passenger compartment
- _____d. Device located in circuit between condenser and evaporator; regulates flow of liquid refrigerant to evaporator
- _____e. Device divided into two parts: the suction side and the discharge side; compresses low-pressure refrigerant vapor from evaporator into hot, high-pressure vapor

1. Condenser
2. Receiver/drier
3. Compressor
4. Expansion valve
5. Evaporator

4. State five safety rules for servicing an air-conditioning system.

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

TEST

5. State three guidelines for protecting the air-conditioning system during service.
- a. _____

 - b. _____

 - c. _____

6. Select from the following list problems caused by air in an air-conditioning system. Write and "X" in the blank before each correct answer.
- _____ a. System performance loss
 - _____ b. High compressor-suction pressures
 - _____ c. High compressor-discharge pressures
 - _____ d. Compressor-oil oxidation
 - _____ e. Low compressor-discharge pressures
7. List problems caused by moisture in an air-conditioning system.
- a. _____
 - b. _____

(NOTE: Test question 8 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

8. Demonstrate the ability to
- a. Discharge and evacuate an automotive air-conditioning system.
 - b. Remove and replace a condenser.
 - c. Remove and replace a receiver/drier.
 - d. Charge an automotive air-conditioning system.
 - e. Leak-test an automotive air-conditioning system.

AIR-CONDITIONING SYSTEM UNIT XIII

ANSWERS TO TEST

1.

a. 13	j. 17
b. 11	k. 5
c. 2	l. 8
d. 16	m. 3
e. 1	n. 4
f. 9	o. 6
g. 12	p. 7
h. 14	q. 15
i. 10	r. 18

2.

a. Condenser	d. Evaporator
b. Receiver/drier	e. Suction side of compressor
c. Expansion valve	f. Discharge side of compressor

3.

a. 1	d. 4
b. 2	e. 3
c. 5	

4. Answer should include any five of the following
 - a. Never service an air-conditioning system until you completely understand air-conditioning service and know how to use the proper equipment for the job
 - b. Always wear eye protection when servicing *any* component of the system
 - c. Never let escaping refrigerant contact your skin or eyes
 - d. Never discharge refrigerant in a room where an open flame is present
 - e. Always discharge refrigerant into shop's exhaust system or into open air
 - f. Never heat a container of refrigerant when charging a system
 - g. When steam cleaning or welding, never apply any form of heat to any component of air-conditioning system
 - h. Avoid inhaling fumes from torch-type leak detector

5. Answer should include any three of the following
 - a. Before servicing the system, study the service manual for the particular make and model vehicle to be worked on
 - b. Immediately cap or plug fittings, valves, and connectors when opening system to atmosphere
 - c. Be sure to charge the system only with refrigerant specifically made for automotive air-conditioning systems
 - d. Always evacuate system after discharging it

ANSWERS TO TEST

6. a, c, d
7. a. Expansion-valve malfunction
b. Acid damage
8. Performance skills evaluated to the satisfaction of the instructor